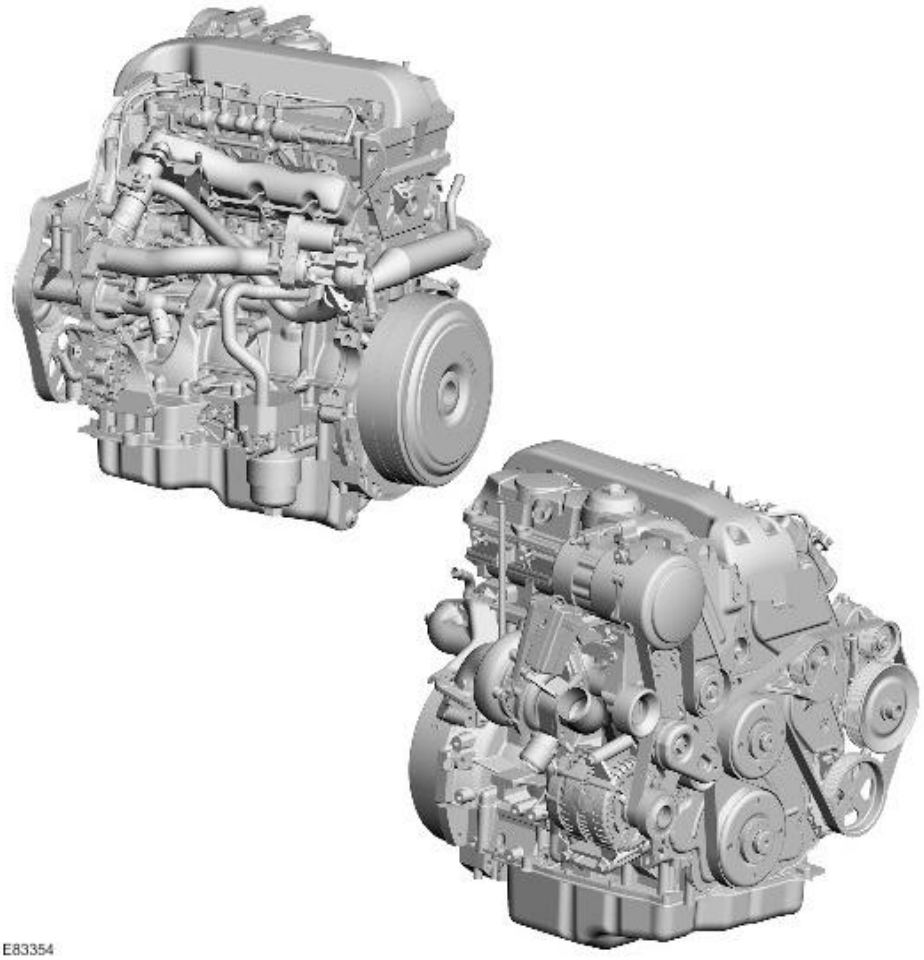
Workshop Manual



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1: General Information

General Information - How To Use This Manual

Description and Operation

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How to use This Manual

This manual covers all aspects necessary in order to service the vehicle effectively.

The manual is structured into five main sections, General Information, Chassis, Powertrain, Electrical and Body and Paint with each section dealing with a specific part of a vehicle system.

Each of the five main sections contain sub-sections dealing with items which form a part of that specific system.

Pages at the start of the manual list all sections available. Each section has a contents list detailing, where applicable, Specifications, Description and Operation, Diagnosis and Testing, General Procedures and Repair Procedures.

Where components need to be removed or disassembled in sequence, each operation in the sequence will be identified numerically and also graphically in an accompanying illustration.

• NOTE: Dimensions quoted are to design engineering specifications with service limits quoted, where applicable.

Workshop Manual Organization

The five main sections, together with the areas which they cover are given below:

- **Section 1** - General Information.
- **Section 2** - Chassis.
- **Section 3** - Powertrain.
- **Section 4** - Electrical.
- **Section 5** - Body and Paint.

Sub-section numbers appear after the initial section number, for example, **Section 412-03** covers air conditioning, which is part of the electrical section.

In the number given above, the first digit of the number **'4'** indicates the section **i.e. Electrical**.

The second and third digits **'12'** of the number indicate the vehicle system **i.e. Air Conditioning**.

The last two digits of the number **'03'** indicate the part of the system covered by the sub-section **i.e. Air Conditioning Compressor**.

General Information - Important Safety Instructions

Description and Operation

Safety Notice

Appropriate service methods and correct repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the safety of the person doing the work. This manual provides general directions for accomplishing service and repair work with tested effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the person doing the work. This manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in the manual must first establish that neither personal safety or vehicle integrity is compromised from choices of methods, tools or parts.

General Information - General Service Information

Description and Operation

Introduction

This manual has been written in a format that is designed to meet the needs of Land Rover technicians worldwide and to assist them in the efficient repair and maintenance of Land Rover vehicles.

This manual provides descriptions and methods for accomplishing adjustment, service and repair work using tested and effective procedures. Following these procedures will help ensure product reliability.

Special Tools

The Special Tool(s) Table provided at the beginning of each procedure lists the special tool(s) required to carry out repair operations within that specific procedure. Wherever possible, illustrations are provided which will assist technicians in identifying the special tool(s) required and also showing such tool(s) in use.

Special tools may be obtained from the manufacturer, SPX Tools, the addresses of their branches will be found in the Special Tools Glossary contained within this Section.

Important Safety Instructions

Appropriate service methods and correct repair procedures are essential for the safe and reliable operation of all motor vehicles as well as ensuring 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. Any person who departs from 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 parts.

Individuals who undertake their own repairs should have some skill or training and limit repairs to components which could not affect the safety of the vehicle or its passengers. Any repairs required to safety critical items such as steering, brakes, suspension or supplemental restraint system should be carried out by a Land Rover Dealer. Repairs to such items should NEVER be attempted by untrained individuals.

Warnings, Cautions and Notes which appear in this manual

As you read through this manual, you will come across Warnings, Cautions and Notes. A Warning, Caution or Note is placed at the beginning of a series of steps. If the warning, caution or note only applies to one step, it is placed at the beginning of the specific step after the step number.

Warnings, Cautions and Notes have the following meanings:

Warning: Procedures which must be followed to avoid the possibility of personal injury.

Caution: Calls attention to procedures which must be followed to avoid damage to components.

Note: Gives helpful information.

References

References to the Left Hand (LH) or Right Hand (RH) side given in this manual are made when viewing the vehicle or unit from the rear.

Fault Diagnostic Equipment

The vehicle is equipped with a number of electronic control systems to provide optimum performance of the vehicle's systems.

Diagnostic Equipment (T4) is available and must be used where specified. The use of this equipment will assist with the fault diagnostic abilities of the Dealer workshop. In particular, the equipment can be used to interrogate the electronic systems for diagnosis of faults which may become evident during the life of the vehicle.

This manual is produced as a reference source to supplement T4.

Features of the equipment include:

a. Fully upgradeable support for the technician

b. Structured diagnostics to accommodate all skill levels

c. Direct print-out of screen information and test results

Testing the vehicle

Operations covered in this manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and tested after completion and if necessary, a road test of the vehicle is carried out, particularly where safety related items are concerned.

Repairs and Replacement Parts

Land Rover parts are manufactured to the same exacting standards as the original factory fitted components. For this reason, it is essential that only genuine Land Rover parts are used during maintenance or repair.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories.

Safety features and corrosion prevention treatments embodied in the vehicle may be impaired if other than Land Rover recommended parts are fitted. In certain territories, legislation prohibits the fitting of parts not to manufacturer's specification. Torque wrench setting figures, where given, must be adhered to and locking devices, where specified must be used. If the efficiency of a locking device is impaired during removal it must be replaced.

Owners purchasing accessories whilst travelling abroad must ensure that the accessory and its fitted location on the vehicle conform to legal requirements.

The terms of the vehicle warranty may be invalidated by the fitting of parts other than those recommended by Land Rover.

• NOTE: The fitting of non-approved Land Rover parts and accessories or the carrying out of non-approved alterations or conversions may be dangerous. Any of the foregoing could affect the safety of the vehicle and occupants; also, the terms and conditions of the vehicle warranty may also be invalidated .

All Land Rover recommended parts have the full backing of the vehicle warranty.

Land Rover Dealers are obliged to supply only Land Rover recommended parts.

Specifications

Land Rover are constantly seeking to improve the specification, design and production of their vehicles and alterations take place accordingly. Whilst every effort is made to ensure the accuracy of this Manual, it should not be regarded as an infallible guide to current specifications of any particular vehicle.

This Manual does not constitute an offer for sale of any particular vehicle. Land Rover dealers are not agents of Land Rover and have no authority to bind the manufacturer by any expressed or implied undertaking or representation.

General Information - Standard Workshop Practices

Description and Operation

Vehicle in Workshop

When working on a vehicle in the workshop always make sure that:

- Where practicable, the parking brake is applied and the wheels are securely chocked to prevent the vehicle moving forwards or backwards.
- Whenever possible, the ignition key is removed before any work is carried out on the vehicle.
- If the engine is to be run, there is adequate ventilation, or an extraction hose is used to remove exhaust fumes.
- There is adequate room to raise the vehicle and remove the wheels, if necessary.
- Fender covers are always installed if any work is to be carried out in the engine compartment.
- Where practicable, the battery is disconnected if working on the engine, underneath the vehicle, or if the vehicle is raised.

CAUTION: When electric arc welding on a vehicle, always disconnect the generator wiring to prevent the possibility of a surge of current causing damage to the internal components of the generator.

- If using welding equipment on the vehicle, a suitable fire extinguisher is readily available.

Battery - General

WARNING: **It is essential that a period of 10 minutes elapses after the battery is disconnected before any work is undertaken on any part of the SRS system.**

• CAUTIONS:

Prior to carrying out any procedures which involve disconnecting/ or connecting the battery, refer to the Electrical Section of this manual - Battery disconnection/connection.
For additional information, refer to: Battery (414-01 Battery, Mounting and Cables, Removal and Installation).

A discharged battery condition may have been caused by an electrical short circuit. If this condition exists there will be an apparently live circuit on the vehicle even when all normal circuits are switched off. This can cause arcing when the jumper cables are connected.

Jump Starting a Vehicle

• CAUTIONS:

While it is not recommended that a vehicle is jump started, it is recognized that this may occasionally be the only practical way to mobilize a vehicle. Reference should be made to the following.

It is advisable not to use starter/charger sets for jump starting but if this is unavoidable, make sure that the sets are not used in the 'START' mode.

- Always make sure that the jumper cables are adequate for the task.
- Always make sure that the slave battery is of the same voltage (12 volts) as the vehicle battery. The batteries must be connected in parallel.
- Make sure that the battery terminals of both batteries are fully tightened.
- Where another vehicle is used to jump start a disabled vehicle, make sure that the two vehicles are not touching.
- It is advisable that the engine of the donor vehicle is switched off during jump starting; take care to make sure that the battery of the donor vehicle does not also become discharged.
- Always make sure that switchable electric circuits are OFF before connecting jump cables. This reduces the risk of arcing occurring when the final connection is made.

Following jump starting of a disabled vehicle, the discharged battery must be checked for serviceability and recharged as soon as possible to avoid permanent damage.

Do not rely on the generator to restore a discharged battery. For a generator to recharge a battery, it would take in excess of eight hours continuous driving with no additional loads placed on the battery.

Trickle charging (defined as voltages <16 volts) may be carried out with the battery connected. Make sure that the battery terminals are fully tightened prior to trickle charging.

CAUTION: Boost charging may only be carried out with the battery disconnected from the vehicle.

Towing the Vehicle

• CAUTIONS:

The vehicle has permanent four-wheel drive. The following towing instructions must be adhered to:

The brake servo and power assisted steering system will not be functional without the engine running. Greater pedal pressure will be required to apply the brakes and the steering system will require greater effort to turn the front road wheels. The vehicle tow connection should be used only in normal conditions, 'snatch' recovery should be avoided.

Towing the vehicle on all four wheels with driver operating steering and brakes.

Turn ignition key to position **1** to release steering lock.

Select neutral in main gearbox and transfer box.

Secure tow rope, chain or cable to front towing eyes.

Release the parking brake.

Rear suspended tow by breakdown vehicle

CAUTION: The steering wheel and/or linkage must be secured in the straight ahead position. Do not use the steering lock mechanism for this purpose.

If the front axle is to be trailed turn ignition key to position **1** to release steering lock.

Select neutral in main gearbox and transfer box.

Transporting the vehicle by trailer

CAUTION: Underbody components must not be used as lashing points.

Lashing/towing eyes are provided on front and rear of the chassis side members to facilitate the securing of the vehicle to a trailer or other means of transportation.

Position vehicle on trailer and apply the parking brake. Select neutral in main gearbox.

General installation Instructions

Component removal

Whenever possible, clean components and the surrounding area before removal.

- Blank off openings exposed by component removal.
- Following disconnection, seal fuel, oil or hydraulic lines immediately using suitable blanking plugs or caps.
- Seal open ends of exposed oilways using suitable tapered hardwood plugs or conspicuous plastic plugs.
- Immediately a component is removed, place it in a suitable container; use a separate container for each component and its associated parts.
- Clean bench and provide marking materials, labels and containers before disassembling components.

Disassembling

Observe scrupulous cleanliness when disassembling components, particularly when brake, fuel, air suspension or hydraulic system parts are disassembled. A particle of dirt or cloth fragment could cause a serious malfunction if trapped in these systems.

- Blow out all tapped holes, crevices, oilways and fluid passages with dry, compressed air.

WARNING: Suitable eye protection must be worn.

- Use suitable marker ink to identify mating parts, do not use a scriber or centre punch as they could initiate cracks or distortion.
- Wire or tape mating parts together where necessary to prevent accidental interchange.
- Suitably identify parts which are to be renewed and to those parts requiring further inspection. Keep these parts separate.
- To make sure that the correct replacement part has been obtained, do not discard a part due for renewal until after comparing it with the new part.

Cleaning components

Always use cleaning agents which are suitable for the work being undertaken and the components being cleaned. NEVER use gasoline (petrol) as a cleaning agent (degreaser). Always make sure that the component being cleaned is compatible with the cleaning agent.

Always follow the manufacturer's instructions regarding the use of cleaning agents and make sure that the environment in which the work is being undertaken is suitable. See Health and Safety Precautions for further information regarding cleaning.

General inspection of components

All components should be inspected for wear or damage before reassembling.

- Always make sure that component to be inspected is clean and free from oil or grease.
- When a component is to be checked dimensionally against design specified values, use the appropriate measuring equipment i.e. micrometers, verniers, surface plates, dial test indicators (DTI).
- Always make sure that all measuring equipment is correctly calibrated before use.
- Reject a component which is not within specified values/limits or if it appears to be damaged.
- A component may be re-installed if dimensions obtained during checking are at the maximum tolerance limit and it is in an undamaged condition.
- Bearing journal clearances should be checked where necessary using Plastigage.
- Gaskets, seals and O-ring seals are to be re-used unless damaged.

Joints and Joint Faces

All gaskets should be installed dry unless stated otherwise. Always apply the specified lubricant to O-rings and install O-rings using the fingers only.

Use gasket removal spray and/or plastic scrapers to remove traces of old gasket.

CAUTION: DO NOT use metal scrapers or emery cloth as these may damage the sealing surfaces.

Many joints use sealants instead of gaskets as the sealing medium. Where this is the case, the sealant together with its part number will be found listed in the relevant repair operation and also in the sealants table.

CAUTION: Always remove all traces of the old sealant prior to reassembly. Use plastic scrapers, specified solvents where available or dry, lint free cloth. DO NOT use metal scrapers or emery cloth as these may damage the sealing surfaces. Make sure that sealing surfaces are free from oil or grease as sealants will not adhere properly to contaminated surfaces.

Do not allow sealant to enter tapped holes or oilways.

Locking Devices

Always replace locking devices with one of the same design and of the correct size.

Tab washers

Always release locking tabs before loosening fixings, do not re-use tab washers.

Locknuts

Always use a backing spanner when loosening and tightening locknuts, brake and fuel pipe unions.

Roll pins

Always install new roll pins of the correct size.

Circlips

Always install new circlips ensuring that they are of the correct size for the groove.

Woodruff keys

Woodruff keys may be re-used provided there is no indication of wear or distortion.

Remove any burrs from edges of keyways using a fine file.

Split pins

Never attempt to straighten and re-use a split pin, always make sure that replacement pins are of the correct size for the hole in which they are to be installed.

Screw Threads

- Damaged nuts, bolts and screws must always be discarded. Attempting to recut or repair damaged threads with a tap or die impairs the strength and install of the threads and is not recommended.

• NOTE: During certain repair operations, it may be necessary to remove traces of thread locking agents using a tap. Where this is necessary, the instruction to do so will appear in the relevant operation and it is essential that a tap of the correct size and thread is used.

- Some bolts are coated with a thread locking agent and unless stated otherwise, they must not be re-used. New bolts having the same part number as the original must always be installed. When nuts or bolts are to be

discarded, the repair operation and relevant torque chart will include an instruction to that effect. Do not use proprietary thread locking agents as they may not meet the specification required. See also Encapsulated ('Patched') Bolts and Screws.

- Always make sure that replacement nuts and bolts are at least equal in strength to those that they are replacing. Castellated nuts must not be loosened to accept a split pin except in recommended cases when this forms part of an adjustment.
- Do not allow oil or grease to enter blind holes, the hydraulic action resulting from tightening the bolt or stud can split the housing and also give a false torque reading.
- Always tighten a nut, bolt or screw to the specified torque figure, damaged or corroded threads can give a false torque reading.
- Nut and bolt loosening and tightening sequences, where given, must ALWAYS be followed. Distortion of components or faulty sealing of joints will result if the sequences are not followed. Where an instruction is given to tighten in stages, these stages must be adhered to; do not attempt to combine stages particularly where certain stages involve tightening by degrees.
- To check or re-tighten a fixing to a specified torque, first loosen a quarter of a turn, then retighten to the specified torque figure.
- Unless instructed otherwise, do not lubricate bolt or nut threads prior to installing.

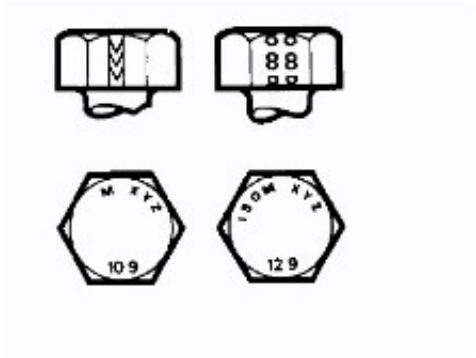
Where it is stated that bolts and screws may be re-used, the following procedures must be carried out:

- Check that threads are undamaged.
- Remove all traces of locking agent from the threads.

CAUTION: DO NOT use a wire brush; take care that threads are not damaged.

- Make sure that threads are clean and free from oil or grease.
- Apply the specified locking agent to the bolt threads.

Bolt and Nut Identification



E48627

An ISO metric bolt or screw made of steel and larger than 6 mm in diameter can be identified by either of the symbols ISO M or M embossed or indented on top of the bolt head.

In addition to marks identifying the manufacturer, the top of the bolt head is also marked with symbols indicating the strength grade e.g. 8.8, 10.9, 12.9, 14.9. Alternatively, some bolts and screws have the M and strength grade symbol stamped on the flats of the hexagon.

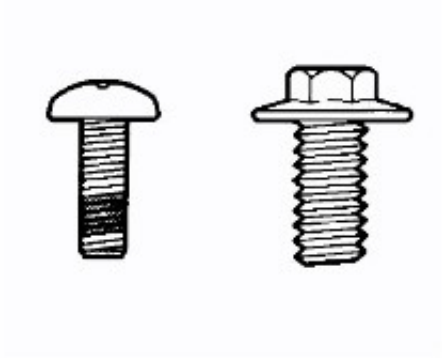
Encapsulated ('Patched') bolts and screws

E48628

Encapsulated ('patched') bolts and screws have a thread locking agent applied to the threads during manufacture. Most thread locking agents are coloured, the band of colour extending for 360° around the thread. Some locking agents

however, are neutral in colour and may not be so easily identified apart from a slightly darker area of thread where the locking agent has been applied. The locking agent is released and activated by the tightening process and is then chemically cured to provide the locking action.

Self-locking bolts and screws



E48629

Unless stated in a specific repair procedure, self-locking bolts and screws i.e. nylon patched or trilobular thread can be re-used provided that resistance is felt when the locking portion enters the female thread.

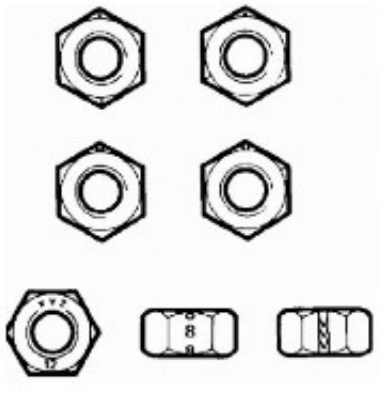
Nylon patched bolts and screws have a locking agent either applied to, or inserted in the threaded portion. They are identified by the presence of a coloured section of thread extending approximately 180° around the thread or by a coloured plug inserted into the bolt.

Trilobular bolts have a special thread form which creates a slight interference with the thread of the hole or nut into which it is screwed.

CAUTION: Do Not re-use self-locking fasteners in critical locations e.g. drive plates/flywheel or engine bearings. Do not install non self-locking fasteners where a self-locking fastener is specified.

Trilobular bolts should not be used as a substitute for patched bolts.

Nut identification



E48630

A nut with an ISO metric thread is marked on one face or one of the hexagonal flats with the strength grade symbol 8, 12, 14. Some nuts with the strength grade 4, 5 or 6 are also marked and some have the metric symbol M on the hexagonal flat opposite the strength grade marking.

A clock face system is sometimes used as an alternative method of indicating the strength grade. The external chamfers or a face of the nut is marked in a position relative to the appropriate hour mark on a clock face to indicate the strength grade.

A dot is used to locate the 12 o'clock position and a dash to indicate the strength grade. If the grade is above 12, two dots identify the 12 o'clock position.

When tightening a slotted or castellated nut, never loosen it to insert a split pin except where specified as part of an adjustment procedure. If difficulty is experienced in correctly positioning the slot, alternative washers or nuts should be selected.

Where a nut is tightened to adjust or maintain bearing pre-load, the tightening procedure must be adhered to.

Self-locking nuts

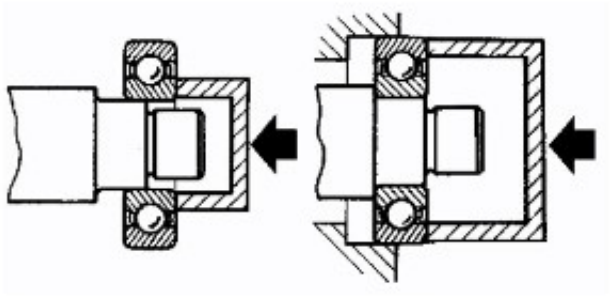
Unless stated otherwise, self-locking nuts once removed must be discarded and new nuts of the same type and strength grade installed.

Ball and Roller Bearings

When removing and installing bearings, make sure that the following practices are observed to make sure component serviceability:

CAUTION: Service tools have been developed for removing the majority of bearings; these must always be used where specified.

- Remove all traces from bearing under inspection by cleaning with a suitable degreasant; maintain absolute cleanliness throughout operations.
- Conduct a visual inspection for markings on rolling elements, raceways, outer surfaces of outer or inner surfaces of inner rings. Reject any bearings found to be marked since marking in these areas indicates onset of wear.
- Hold inner race of bearing between finger and thumb of one hand and rotate outer race to check that it revolves absolutely smoothly. Repeat holding outer race and rotating inner race. DO NOT spin the bearing.
- Rotate outer ring gently using a reciprocating movement whilst holding inner ring; feel for any check or obstruction to rotation. Reject bearing if movement is not absolutely smooth.
- Check bearing for blueing or signs of overheating.
- Lubricate bearing with the specified lubricant.
- Inspect bearing surface of shaft and bearing housing for discolouration or other markings which indicate overheating of bearing or movement between bearing and seating.
- Before installing bearing, make sure that shaft and bearing housing are clean and free from burrs.
- If one bearing of a pair shows signs of wear, overheating etc., it is advisable to replace bearings as a pair unless it is suspected that one bearing may have been faulty when installed, was installed incorrectly or the fault arose due to oil seal failure.
- Never reinstall a bearing unless it is in a fully serviceable condition.



E48560

- When installing a bearing to a shaft, only apply force to the inner ring of the bearing. When installing a bearing into a housing, only apply force to the outer ring of the bearing.

CAUTION: Service tools have been developed for installing the majority of bearings; these must always be used where specified.

- In the case of grease lubricated bearings, fill the space between the bearing and outer seal with the recommended grade of grease before installing the seal.

CAUTION: When a waxed oil seal (installed dry) type of oil seal is to be installed, take great care that grease does not contaminate the running surface of the seal.

- Always make suitable reference marks between the components of separable bearings e.g. taper roller bearings when disassembling to make sure correct location of components when assembling. Never install new rollers in an outer ring, always install a new bearing assembly.

Brake Pads and Linings

Always install the correct grade and specification of brake pads and linings. When replacing these items, always replace as complete axle sets.

Brake Hydraulics

Always observe the following recommendations when working on the braking system:

WARNING: Do not intermix brake fluid of different specifications.

- Always use two spanners when loosening or tightening brake pipes or hose connections.
- Make sure that hoses run in a natural curve and are not kinked or twisted.
- install brake pipes and hoses securely in their retaining clips and make sure that they cannot contact a potential chafing point.
- Containers used for brake fluid must be kept absolutely clean.
- Do not store brake fluid in unsealed containers, the fluid will absorb water which will lower the boiling point of the fluid.
- Do not allow brake fluid to be contaminated with other fluids such as mineral oil and do not put brake fluid in a container which has previously been used for storing other fluids.
- Do not re-use brake fluid which has been bled from the system.
- Always use brake fluid or a suitable brake cleaning fluid to clean hydraulic components.
- Unless stated otherwise, use only clean brake fluid to lubricate hydraulic seals and components.
- Always install blanking plugs to hoses, pipes or components immediately after disconnection.
- Check thread compatibility of original equipment with replacement components.
- Observe absolute cleanliness when working with hydraulic components.

Pipes and Hoses

When removing or installing flexible hydraulic pipes and hoses, make sure that the following procedures are observed to make sure component serviceability:

- Prior to removal, clean area around hose or pipe end which is to be disconnected.
- Obtain appropriate blanking plugs or caps before disconnecting hose or pipe end fittings in order that connections can be plugged immediately following disconnection.
- Always install blanking plugs or caps to pipes and unions immediately following disconnection.
- Clean hose or pipe and blow through with an air line.

WARNING: Suitable eye protection must be worn.

- Check hoses externally for cracks, separation of plies, security of end fittings and external damage; replace faulty hoses.
- Check pipes for signs of corrosion and chafing, replace as necessary.

CAUTION: If pipes are found to be chafed, rectify clips, mounting points etc., to prevent further problems in service.

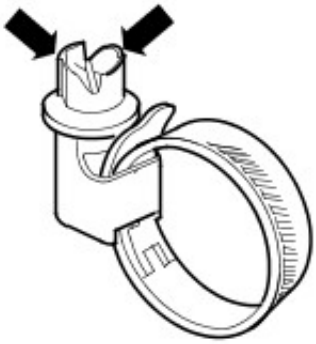
- When installing hoses, make sure that no unnecessary bends are introduced and that hoses are not kinked, twisted or positioned close to potential chafing points.
- When installing pipes, make sure that pipes are positioned and clipped clear of potential chafing points.
- Always replace sealing washers installed to banjo bolts, sealing plugs etc.
- Always use a backing spanner when tightening unions and do not overtighten union nuts or banjo bolts.
- After engagement of 'quick-fit' connection hoses, perform a 'tug' test to make sure connection is securely installed.
- After any work on hydraulic systems, always check for fluid leaks whilst a second operator applies working pressure to the brake pedal or operates the system that has been worked on.

Fuel system hoses

Some fuel hoses are made up of two laminations, an armoured rubber outer sleeve and an inner viton core. Whenever a hose is removed, make sure that the inner bore is inspected to check that the viton lining has not become separated from the outer sleeve.

WARNING: Never attempt to repair fuel hoses or rectify leaking 'quick-fit' connectors. The fuel hose and connectors must be replaced as an assembly.

Fuel system hose clips



E48636

Certain fuel system hose clips are of the 'break-off head' type where a slot in the screw head shears off when the clip is tightened to a specific torque. These clips may be removed using a screwdriver and must be replaced with new clips on reassembly. Clips must be tightened until the portion of the slot shears off. Do not attempt to tighten clips by any other method, do not install any other type of clip.

'Quick-fit' connections are also installed to certain fuel hoses. After engagement of 'quick-fit' connections, perform a 'tug' test to make sure connection is securely installed.

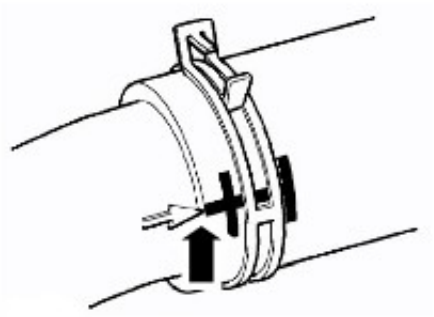
Other fuel system hose clips are of the 'Jubilee' type and there may be a tamper proof cover installed over the screw head. These cover must be carefully removed before slackening the clip and should be replaced after final tightening, ensuring that the internal hexagon on the cover is correctly located on the clip screw.

Cooling system hoses

CAUTION: The following precautions must be observed to make sure that the integrity of the cooling system hoses and their connection to the system is maintained.

Hose orientation and connection

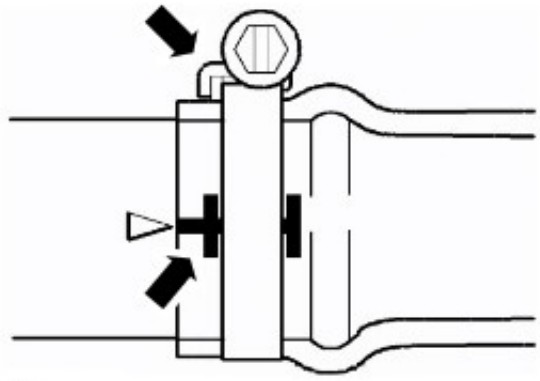
Correct orientation of cooling system hoses is important to make sure that hoses do not become fatigued or damaged through contact with adjacent components.



E48633

Where orientation marks are provided on the hose and corresponding component, the marks must be aligned when the hose is installed. Hoses must be installed fully on to their connection points, usually a moulded form on a pipe provides a positive indicator.

Hose clips



E48634

Markings are usually provided on the hose to indicate the correct clip position. If no markings are provided, position the clip directly behind the retaining lip at the end of the stub pipe. Worm drive clips should be orientated with the crimped side of the drive housing facing towards the end of the hose or the hose may become pinched between the clip and the stub pipe retaining lip. Unless otherwise stated, worm drive clips should be tightened to 3 Nm (2 lb-ft). Make sure that hose clips do not foul adjacent components.

E48635

Oetiker clips may be removed by bending the tag (arrowed) and releasing the free end of the clip. Clips must not be re-used. When installing new clips, make sure clip is positioned on hose before tightening and make sure that when clip is tightened, the tag is located in the longitudinal slot in the free end of the clip (arrowed in illustration).

'Quick-fit' connections are also installed to certain hoses/pipes. Inspect 'quick-fit' connections for damage, prior to connection. Replace if damaged. After engagement of 'quick-fit' connections, perform a 'tug' test to make sure connection is securely installed.

Heat protection

Always make sure that heat shields and protective sheathing are in good condition; replace if damage is evident. Particular care must be taken when routing hoses close to hot engine components such as the exhaust manifolds and exhaust gas recirculation (EGR) pipes. Hoses will relax and deflect slightly when hot, make sure this movement is taken into account when routing and securing hoses.

Electrical Precautions

General

The following guidelines are intended to make sure the safety of the operator whilst preventing damage to the electrical and electronic components of this vehicle.

Equipment

Prior to commencing any test procedure on the vehicle, make sure that the relevant test equipment is working correctly and that any harness or connectors are in good condition. It is particularly important to check the condition of all plugs and leads of mains operated equipment.

Polarity

Never reverse connect the vehicle battery and always make sure the correct polarity when connecting test equipment.

High voltage circuits

Whenever disconnecting live ht circuits, always use insulated pliers and never allow the open end of the ht lead to contact other components, particularly ECU's.

Connectors and harnesses

The engine compartment of a vehicle is a particularly hostile environment for electrical components and connectors. Always observe the following:

- Make sure electrically related items are dry and oil free before disconnecting/connecting test equipment.
- Make sure that disconnected multiplugs and sensors are protected from any possible oil, coolant or other liquid contamination. Any such contamination could impair performance or lead to component failure.
- Never force connectors apart or pull on the wiring harness.
- Always make sure locking tabs are disengaged before disconnecting multiplugs etc. and make sure that correct orientation is achieved before connection.
- Make sure that any protection covers, insulation etc. are replaced if disturbed.

Having confirmed that a component is faulty, carry out th following:

- Switch off the ignition and disconnect the battery.
- Remove the component and support the disconnected harness.
- When replacing electrical components, keep oily hands away from electrical connections and make sure that locking tabs on connectors are fully engaged.

Battery Disconnection/Connection

Always refer to the Electrical Section of this manual - Battery Connection/Disconnection prior to attempting to connect

or disconnect the battery.
For additional information, refer to: Battery (414-01 Battery, Mounting and Cables, Removal and Installation).

Fuel Handling Precautions

The following information lists basic precautions which must be observed if fuel is to be handled safely. It also outlines other areas of risk which must not be ignored. As this information is issued for basic guidance only, consult your local Fire Department where any doubt as to personal and environmental safety exists - See also Health and Safety Precautions.

General precautions

Always have the correct type of fire extinguisher containing Foam, CO2, Gas or powder accessible when handling or draining fuel or dismantling fuel systems. Fire extinguishers must also be located in areas where fuel is stored.

Make sure that suitable warning signs are exhibited.

Keep all sources of ignition well away from areas where fuel is being handled.

Make sure that any leadlamps are flameproof and kept clear of spillage.

• WARNINGS:

Do not disassemble or reassemble fuel system components whilst vehicle is over a pit.

No one should be permitted to repair components associated with fuel without first having specialist training.

Always disconnect the vehicle battery before carrying out disassembly, reassembly or draining work on a fuel system.

Fuel tank and system draining

Draining must be carried out in accordance with the procedures given in the relevant Fuel System section of this manual.

• WARNINGS:

Never drain fuel or work on a fuel system while the vehicle is over a pit. Extraction or draining of fuel must be carried out in a well ventilated area.

Never switch on or operate mobile (cellular) phones in the vicinity of vehicles when operations are being carried out on the fuel system.

Always attach fuel vapour warning labels to fuel tanks immediately after draining.

Containers used for storing fuel must be clearly marked with the contents and placed in a safe storage area which meets the requirements of the local authority.

CAUTION: Some fuel lines are now installed with 'quick release' connectors. If a connector is damaged, no attempt must be made to repair the connector, a new fuel line and connector(s) assembly must be installed.

Always release pipe clips fully before attempting to disconnect fuel pipes.

Fuel tank repairs

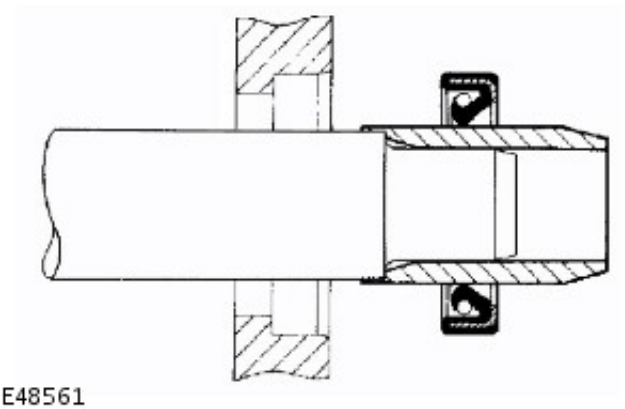
CAUTION: No attempt should be made to repair a fuel tank. If the structure of the tank is damaged, a new tank must be installed.

Oil seals

Never use a seal which has been improperly stored or handled.

- Take great care when removing old seals that the sealing surfaces and seal housing are not damaged.
- Carefully examine seal before installing to make sure that it is clean and undamaged.
- Make sure that the surface on which the seal is to run and also the seal housing is clean and free from burrs or scratches. Renew the component if the sealing surface cannot be restored.
- Special tools and protection sleeves are provided for installing the majority of seals and must be used when specified.
- Many seals are now coated with a protective wax and DO NOT need to be lubricated prior to installing. Always check the relevant repair procedure which will state if a seal must be installed dry. Never touch these seals with oily hands as the oil will contaminate the protective coating and affect the sealing properties of the seal; also, make sure that installing tools and protection sleeves are free from oil and grease. Seals which must be

lubricated prior to installing should have the recommended lubricant applied to the areas specified in the repair procedure.
- Make sure that a seal is installed the correct way round. For example, the lip of the seal must face towards the lubricant which it is sealing.
- When installing an oil seal, make sure that it is positioned square to shaft and housing. Where the seal is to be installed to a housing prior to installing over a shaft, take care not to allow the weight of an unsupported shaft to rest on the seal.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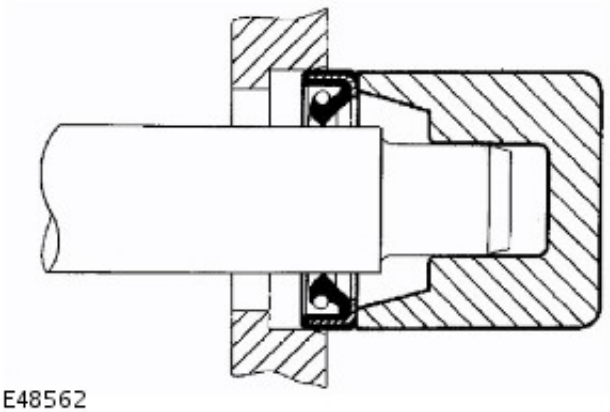
- Always use the recommended special tool and protection sleeve to install an oil seal. If no tool is specified, use a suitable mandrel approximately 0.4 mm (0.015 in) smaller than the outside diameter of the seal. Use adhesive tape on the shaft to protect the sealing lip of the seal.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- Press or drift the seal in to the depth of its housing if the housing is shouldered or flush with the face of the housing where no shoulder is provided. Make sure that the seal is not tilted in the housing when it is installed.

(A/C) System Precautions

The A/C system contains fluids and components which could be potentially hazardous to the service engineer or the environment if not serviced and handled correctly. The following guidelines are intended to alert the service engineer to potential sources of danger and emphasise the importance of ensuring the integrity of the A/C operating conditions and components installed to the vehicle.

Where necessary, additional specific precautions are detailed in the relevant sections of this Manual and also in the Health and Safety Section. These precautions must be referred to prior to commencing repair operations.

The refrigerant used in the A/C system is HC-134a (Hydro fluorocarbon) R134a.

• WARNINGS:

Servicing must only be carried out by personnel familiar with both the vehicle system and the charging and testing equipment. All operations must be carried out in a well ventilated area away from open flame and heat sources.

R134a is a hazardous liquid and when handled incorrectly can cause serious injury. Suitable protective clothing, consisting of face protection, heat proof gloves, rubber boots and rubber apron or waterproof overalls, must be worn when carrying out operations on the A/C system.

Remedial actions

WARNING: Due to its low evaporating temperature, R134a must be handled with care. R134a splashed on any part of the body will cause immediate freezing of that area. Any refrigerant cylinders and replenishment trolleys when

discharging will freeze skin to them if contact is made.

If an accident involving R134a should occur, conduct the following remedial actions:

- If liquid R134a enters the eye, do not rub it. Gently run large quantities of eye wash over affected eye to raise the temperature. If an eye wash is not available, cool, clean water may be used to flush the eye. After rinsing, cover the eye with a clean pad and seek immediate medical attention.
- If liquid R134a is splashed onto the skin, run large quantities of water over the affected area to raise the temperature. Implement the same action if the skin comes in contact with discharging cylinders. Wrap the contaminated body parts in blankets (or similar materials) and seek immediate medical attention.
- If the debilitating effects of inhalation of R134a vapour are suspected, seek fresh air. If the affected person is unconscious, move them away from the contaminated area to fresh air and apply artificial respiration and/or oxygen and seek immediate medical attention.

Service precautions

Observe the following precautions when handling components used in the system:

- A/C units must not be lifted by their hoses, pipes or capillary lines.
- Hoses and lines must not be subjected to any twist or stress; the efficiency of the system will be impaired by kinks or restrictions. Make sure that hoses are correctly positioned before tightening couplings, and make sure that all clips and supports are utilised.
- Flexible hoses should not be positioned closer than 100 mm (4.0 in) to the exhaust manifold unless protected by heat shielding.
- Completed assemblies must be checked for refrigeration lines touching metal panels. Any direct contact of components and panels may transmit noise and so must be eliminated.
- The appropriate torque wrench must be used when tightening refrigerant connections to the stipulated value. An additional spanner must be used to hold the union to prevent twisting of the pipe when tightening connections.
- Before connecting any hose or pipe, make sure that refrigerant oil is applied to the seat of the new O-rings, **BUT NOT** to the threads of the connection.
- All protective plugs or caps must remain in place in the component until immediately prior to connection.
- Make sure components are at room temperature before uncapping/unplugging, to prevent condensation of moisture from the air that enters it.
- When disconnecting, immediately plug or cap all pipes to prevent ingress of dirt and moisture into the system.
- Components must not remain uncapped/unplugged, if a system has been left uncapped/unplugged for 24 hours or longer, a new receiver/drier must be installed.
- The receiver/drier contains desiccant which absorbs moisture. It must be positively sealed at all times. A receiver/drier that has been left uncapped for longer than 24 hours must not be used; install a new unit.
- The receiver/drier should be the last component connected to the system to make sure optimum dehydration and maximum moisture protection of the system.
- Whenever a component of the refrigeration system is replaced, it will also be necessary to install a new receiver/drier unit.
- Use alcohol and a clean lint-free cloth to clean dirty connections.
- Make sure that all new parts installed are marked for use with R134a.
- When a major repair has been completed, a leak test should be conducted; refer to the Repairs Section of this manual for the correct procedure.

Refrigerant oil

CAUTION: Refrigerant oil (ND-8 PAG) easily absorbs water and must not be stored for long periods. Do not pour unused refrigerant oil back into the container. Always use an approved refrigerant oil.

When replacing components in the system, drain the refrigerant oil from the component being replaced into a graduated container. On assembly, add the quantity of refrigerant oil drained to the new component - See Compressor Replacement in this Section.

A/C Compressor

A new compressor is sealed and pressurised with Nitrogen gas. When installing a new compressor, slowly release the sealing cap; gas pressure should be heard to vent as the seal is broken.

CAUTION: A new compressor should always be sealed and could be pressurised with nitrogen gas. To avoid possible oil loss, release the sealing cap(s) slowly. Do not remove the cap(s) until immediately prior to connecting the pipes to the compressor.

Rapid refrigerant discharge

If the A/C system is damaged as a result of an accident and the system is punctured, the refrigerant will discharge rapidly. The rapid discharge of refrigerant will also result in the loss of most of the oil from the system. The compressor must be removed and all the remaining oil in the compressor drained and refilled as instructed in the air conditioning section of this manual.

Precautions for refrigerant recovery, recycling and recharging

When the A/C system is recharged, any existing refrigerant is first recovered from the system and recycled. The system is then charged with the required weight of refrigerant and volume of refrigerant oil.

WARNING: Refrigerant must always be recycled before re-use to make sure that the purity of the refrigerant is high enough for safe use in the system. Recycling should always be carried out with equipment which is design certified by Underwriter Laboratory Inc. for compliance with SAE J1991. Other equipment may not recycle refrigerant to the required level of purity.

• CAUTIONS:

A R134a Refrigerant Recovery Recycling Recharging Station must not be used with any other type of refrigerant. Refrigerant R134a from domestic and commercial sources must not be used in motor vehicle systems.

The system must be evacuated immediately before recharging commences. Delay between evacuation and recharging is not permitted.

A/C Compressor Replacement

A new compressor is supplied filled with a full charge (X cm^3) of refrigerant oil.

A calculated quantity of oil must be drained from the new compressor before installing. To calculate the quantity of oil to be drained:

- Remove the drain plug from the old compressor.
- Invert the compressor and gravity drain the oil into a calibrated measuring cylinder. Rotate the compressor clutch to make sure the compressor is completely drained.
- Note the quantity of oil drained (Y cm^3).
- Calculate the quantity of oil to be drained from the new compressor using the following formula:**X cm^3 — (Y cm^3 + 20 cm^3) = Q cm^3**
- Remove the drain plug from the new compressor and drain Q cm^3 of oil. Install and tighten the compressor drain plug.

Vehicle Weights up to 07/2001

When loading a vehicle to its maximum (Gross Vehicle Weight) consideration must be taken of the unladen vehicle weight and distribution of the payload to make sure that axle loadings do not exceed the permitted maximum values.

It is the customer's repsonsibility to limit the vehicle's payload in an appropriate manner such that neither maximum axle loads nor Gross Vehicle Weight are exceeded.

• NOTE: Axle weights are not accumulative. The individual maximum axle weights and gross vehicle weights must not be exceeded.

• NOTE: EEC Kerb weight = Unladen weight + full fuel tank + 75 Kg (165lb).

90 Models

Vehicle axle weights -	Standard	Standard	High load	High load
Front axle	1200 Kg	2645 lb	1200 Kg	2645 lb
Rear axle	1380 Kg	3042 lb	1500 Kg	3307 lb
Maximum Gross Vehicle Weight (GVW) -	2400 Kg	5291 lb	2550	5622 lb
EEC Vehicle kerb weights				
Soft top	1695 Kg	3736 lb	1699 Kg	3745 lb
Pick-up	1694 Kg	3734 lb	1698 Kg	3743 lb
Hard top	1746 Kg	3849 lb	1750 Kg	3858 lb
Station wagon	1793 Kg	3952 lb	1797 Kg	3961 lb

110 Models

Vehicle axle weights -	Levelled	Levelled	Unlevelled	Unlevelled
Front axle	1200 Kg	2645 lb	1200 Kg	2645 lb
Rear axle	1750 Kg	3858 lb	1850 Kg	4078 lb
Maximum Gross Vehicle Weight (GVW) -	2950 Kg	6503 lb	3050 Kg	6724 lb
EEC Vehicle kerb weights	**Standard**	**Standard**	**High load**	**High load**
Soft top	1872 Kg	4127 lb	1882 KG	4149 lb
Pick-up	1880 Kg	4144 lb	1890 Kg	4166 lb
High capacity Pick-up	1917 Kg	4226 lb	1927 Kg	4248 lb
Hard top	1913 Kg	4217 lb	1923 Kg	4239 lb
Station wagon	2018 Kg	4448 lb	2018 Kg	4470 lb
County station wagon	2054 Kg	4528 lb	2054 Kg	455 lb

130 Models

Vehicle axle weights - 130 models		
Front axle	1580 kg	3483 lb
Rear axle	2200 Kg	4850 lb
Maximum Gross Vehicle Weight (GVW) -	3500 kg	7716 lb
EEC Vehicle kerb weights		

Crew cab and high capacity pick-up	2086 Kg	4598 lb

Vehicle Weights From 07/2001

90 Models

Vehicle axle weights - 90 models	Station wagon	Station wagon	Utility	Utility
Front axle	1200 Kg	2645 lb	1200 Kg	2645 lb
Rear axle	1500 Kg	3307 lb	1500 Kg	3307 lb
Maximum Gross Vehicle Weight (GVW) -	2550 Kg	5622 lb	2400	5291 lb
EEC Vehicle kerb weights				
Soft top	1770 Kg	3402 lb	1993 Kg	4393 lb
Pick -up	1770 Kg	3402 lb	1993 Kg	4393 lb
Hard top	1815 Kg	4001 lb	1987 Kg	4380 lb
Station wagon	1870- 1885 Kg	4122 - 4155 lb	1989 - 1998 Kg	4385 - 4404 lb

110 Models - Non Japanese specification

Vehicle axle weights -	Station wagon	Station wagon	Utility	Utility
Front axle	1200 Kg	2645 lb	1200 Kg	2645 lb
Rear axle	1750 Kg	3858 lb	1850 Kg	4078 lb
Maximum Gross Vehicle Weight (GVW) -	2950 Kg	6503 lb	3050 Kg	6724 lb
EEC Vehicle kerb weights	**Standard**	**Standard**	**Heavy duty**	**Heavy duty**
Soft top	1885 Kg	4155 lb	2080 KG	4585 lb
High capacity Pick-up	1920 Kg	4232 lb	2122 Kg	4678 lb
Hard top	1920 Kg	4232 lb	2110 Kg	4651 lb
Station wagon	2055 Kg	4530 lb	2229 Kg	4914 lb

110 Models - Japanese specification

Vehicle axle weights -	Metric	Imperial
Front axle	1115 Kg	2457 lb
Rear axle	2180 Kg	4805 lb
Maximum Gross Vehicle Weight (GVW) -	3295 Kg	7262 lb

130 Models

Vehicle axle weights	Metric	Imperial
Front axle	1580 kg	3483 lb
Rear axle	2200 Kg	4850 lb
Maximum Gross Vehicle Weight (GVW) -	3500 kg	7716 lb
EEC Vehicle kerb weights	**Heavy duty**	**Heavy duty**
Crew cab and high capacity pick-up	2177 - 2286 Kg	4667 - 5039 lb

Towing weights

- NOTE: * Only applies to vehicles modified to accept coupled brakes.
- NOTE: All weight figures are subject to local restrictions

Towing weights	On-road	On-road	Off-road	Off-road
Unbraked trailers	750 Kg	1653 lb	500 Kg	1102 lb
Trailers with overrun brakes	3500 Kg	7716 lb	1000 Kg	2204lb
4 wheel Trailers with coupled brakes *	4000 Kg	8818 lb	1000 Kg	2204lb

Off Road Performance

90 Models

- NOTE: Departure angles do not account for the addition of a tow hitch.

Item	Metric	Imperial
Max. gradient (EEC Kerb weight)	45°	
Approach angle		
Soft Top and Pick-up (EEC Kerb weight)	48°	
Hard top and Station wagon (EEC Kerb weight)	51.5°	
Departure angle		
Soft Top and Pick-up (EEC Kerb weight)	49°	
Hard top and Station wagon (EEC Kerb weight)	53°	
Wading depth	500 mm	20 in
Min. ground clearance (unladen)		
Soft Top and Pick-up (EEC Kerb weight)	191 mm	7.5 in
Hard top and Station wagon (EEC Kerb weight)	229 mm	9.0 in

110 and 130 Models

- NOTE: Departure angles do not account for the addition of a tow hitch.

Item	Metric	Imperial

Max. gradient (EEC Kerb weight)	45°	
Approach angle	50°	
Departure angle		
110 Models	35°	
130 Models	34°	
Wading depth	500 mm	20 in
Min. ground clearance (unladen)	215 mm	8.5 in

Vehicle dimensions

90 Models

Item	Metric	Imperial
Overall length		
Soft top and Pick-up	3722 mm	146.5 in
Hard top and Station wagon	3883 mm	152.9 in
Overall width	1790 mm	70.5
Overall height		
Soft top and Pick-up	1965 mm	77.4 in
Pick-up and Station wagon	1963 mm	77.3 in
Hardtop	1972 mm	77.6 in
Wheelbase	2360 mm	92.9 in
Track front/rear	1486 mm	58.5 in
Width between wheel boxes	925 mm	36.4 in

110 Models

Item	Metric	Imperial
Overall length		
Soft top and Pick-up	4438 mm	175 in
Hard capacity pick-up	4631 mm	182 in
Hardtop/station and county	4599 mm	181 in
Overall width	1790 mm	70.5 in
Overall height -		
Non Japanese specification	2035 mm	80.1 in
Japanese specification	2060 mm	81.1 in
Wheelbase	2794 mm	110 in
Track front/rear	1486 mm	58.5 in
Width between wheel boxes		
High capacity pick-up	1090 mm	43 in
All other models	925 mm	36.4 in

130 Models

Item	Metric	Imperial
Overall length	5132 mm	202 in
Overall width	1790 mm	70.5 in
Overall height	2035 mm	80.1 in
Wheelbase	3266 mm	127 in
Track front/rear	1486 mm	58.5 in
Width between wheel boxes	1090 mm	43 in

V8 Models

Item	Metric	Imperial
Overall length	4072 mm	160.5 in
Overall width	1790 mm	70.5 in
Overall height	2037 mm	80.2 in
Wheelbase	2360 mm	92.9 in
Track front/rear	1486 mm	58.5 in
Width between wheel boxes	925 mm	36.4 in
Turning circle	12.65 m	41 ft 6 in

General Information - Health and Safety Precautions

Description and Operation

Introduction

Modern vehicles contain many materials and liquids which if not handled with care can be hazardous to both personal health and the environment. Also, many of the procedures associated with vehicle maintenance and repair involve physical hazards or other risks to health.

This subsection lists some of these hazardous operations and the materials and equipment associated with them. Precautions necessary to avoid these hazards are identified.

The list is not exhaustive and all operations and procedures and the handling of materials, should be carried out with health and safety in mind.

Before using any product the Materials Safety Data Sheet supplied by the manufacturer or supplier should be consulted.

WARNING: Many liquids and other substances used in motor vehicles are poisonous and should under no circumstances be consumed and should, as far as possible, be kept from contact with the skin. These liquids and substances include acid, anti-freeze, brake fluid, fuel, windscreen washer additives, lubricants, refrigerants and various adhesives.

Acids and Alkalis

For example - alkalis such as caustic soda used in cleaning materials; acids such as sulphuric acid used in batteries.

Both alkalis and acids are irritant and corrosive to the skin, eyes, nose and throat. They cause burns and can destroy ordinary protective clothing.

Avoid splashes to the skin, eyes and clothing. Wear suitable protective impervious apron, gloves and goggles. Do not breath mists.

Make sure access to eye wash bottles, shower and soap are readily available for splashing accidents.

Display Eye Hazard sign.

Air Bags

Highly flammable, explosive – observe No Smoking policy.

Used within the vehicle as safety restraints.

The inflator contains a high-energy propellant which, when ignited, produces a VERY HOT GAS (2500°C).

The gas inflator (generator) used in air bags is Sodium Azide. This material is hermetically sealed in each air bag module and is completely consumed during deployment. No attempt should be made to open an air bag inflator as this will lead to the risk of exposure to Sodium Azide. If a gas generator is ruptured, full protective clothing should be worn when dealing with the spillage.

After normal deployment, gloves and safety goggles should be worn during the handling process.

Deployed air bags should be disposed of in a plastic bag in accordance with local regulations at an approved chemical waste site.

Following any direct contact with Sodium Azide:

- Wash affected areas thoroughly with water.
- **SEEK IMMEDIATE MEDICAL ASSISTANCE.**

Air Bags - Do's

- Do store modules in an upright position.
- Do keep modules dry.
- Do carry modules with the cover side pointing away from the body.
- Do place modules with their cover side upwards.
- Do carefully inspect modules for damage.
- Do stand to one side when connecting modules.
- Do make sure all test equipment is properly calibrated and maintained.
- Do wash hands after handling deployed air bags.

Air Bags - Do Not

- Do Not store highly flammable material together with modules or gas generators.
- Do Not store gas generators at temperatures exceeding 80°C.
- Do Not store modules upside down.
- Do Not attempt to open a gas generator housing.
- Do Not expose gas generators to open flame or sources of heat.

- Do Not place anything on top of a module cover.
- Do Not use damaged modules.
- Do Not touch a fired module or gas generator for at least 10 minutes after firing.
- Do Not use any electrical probes on the wiring circuit.

Air Suspension

Whenever work is being undertaken on the air suspension system, suitable eye protection must be worn.

Air Conditioning Refrigerant

Highly flammable, combustible – observe No Smoking policy.

Skin contact may result in frostbite.

Instructions given by the manufacturer must be followed. Avoid naked lights, wear suitable protective gloves and goggles.

If refrigerant comes into contact with the skin or eyes, rinse the affected areas with water immediately. Eyes should also be rinsed with an appropriate irrigation solution such as a solution of 9% Sodium Chloride and Purified Water. **DO NOT RUB THE EYES AND SEEK IMMEDIATE MEDICAL ATTENTION.**

Air Conditioning Refrigerant

Do Not

- Do Not expose refrigerant bottles to sunlight or heat.
- Do Not expose refrigerant bottles to frost.
- Do Not drop refrigerant bottles.
- Do Not vent refrigerant to atmosphere under any circumstance.
- Do Not mix refrigerants.

Adhesives and Sealants

Many adhesives and sealants are highly flammable – OBSERVE NO SMOKING POLICY. These items, should be stored in flameproof cabinets in No Smoking areas. Cleanliness and tidiness in use should be observed, for example disposable paper covering benches. All adhesives and sealants should be dispensed from applicators where possible; containers, including secondary containers, should be labelled appropriately.

Anaerobic, Cyanoacrylate (super-glues) and other Acrylic Adhesives

Many are irritant, sensitizing or harmful to the skin and respiratory tract. Some are eye irritants.

Skin and eye contact should be avoided and the manufacturer's instructions followed.

Cyanoacrylate adhesives (super-glues) MUST NOT contact the skin or eyes. If skin or eye tissue is bonded, cover with a clean moist pad and **SEEK IMMEDIATE MEDICAL ATTENTION.** Do not attempt to pull skin tissue apart. Use in well ventilated areas as vapors can cause irritation to the nose and eyes.

For two-pack systems see Resin-based and Isocyanate Adhesives/Sealers.

Solvent-based Adhesives/Sealers - See Solvents

Follow manufacturers instructions.

Water-based Adhesives/Sealers

Those based on polymer emulsions and rubber/latex may contain small amounts of volatile, toxic and harmful chemicals. Skin and eye contact should be avoided and adequate ventilation provided during use.

Hot Melt Adhesives

In the solid state, they are safe. In the molten state they may cause burns and health hazards may arise from the inhalation of toxic fumes.

Use appropriate protective clothing and a thermostatically controlled heater with a thermal cut-out and adequate extraction.

Resin-based Adhesives/Sealers, for example Epoxide and Formaldehyde Resin-based

Mixing should be carried out in well ventilated areas as harmful or toxic volatile chemicals may be released.

Skin contact with uncured resins and hardeners can result in irritation, dermatitis, and absorption of toxic or harmful chemicals through the skin. Splashes can damage the eyes.

Provide adequate ventilation and avoid skin and eye contact.

Isocyanate (Polyurethane) Adhesives/Sealers

See also Resin-based Adhesives

Individuals suffering from asthma or respiratory allergies should not work with or near these materials as sensitivity reactions can occur.

Over exposure is irritating to the eyes and respiratory system. Excessive concentrations may produce effects on the nervous system including drowsiness. In extreme cases, loss of consciousness may result. Long term exposure to vapour concentrations may result in adverse health effects.

Prolonged contact with the skin may lead to skin irritation and in some cases, dermatitis.

Splashes entering the eye will cause discomfort and possible damage.

Any spraying should preferably be carried out in ventilated booths which incorporate facilities for removing vapors and spray droplets from the breathing zone.

Wear appropriate gloves, eye and respiratory protection.

Antifreeze

May be flammable when undiluted.

Vapors may be given off from coolant antifreeze when heated. Avoid breathing these vapors.

Antifreeze may be absorbed through the skin in toxic or harmful quantities. Antifreeze, if swallowed, can be fatal; **SEEK IMMEDIATE MEDICAL ATTENTION.**

Battery Acids

See also Alkalis and Acids.

Gases released during battery charging are explosive. Always remove the battery from the vehicle prior to charging. Never use naked flames or allow sparks near charging or recently charged batteries. NEVER add acid to a battery, the chemical reaction produced will be violent and explosive. In cases of eye contact, wash affected area with copious amounts of water and **SEEK IMMEDIATE MEDICAL ATTENTION.**

Make sure there is adequate ventilation during battery charging, observe NO SMOKING POLICY.

Brake Pads and Linings

Always fit the correct grade and specification of brake pads and linings. When renewing pads and linings, always replace as complete axle sets.

Brake and Clutch Fluid

Splashes to the skin and eyes are irritating and in the long term can be damaging, avoid prolonged skin contact. In cases of eye contact, wash affected area with copious amounts of water and SEEK IMMEDIATE MEDICAL ATTENTION.

Chemical Materials

All chemical materials should always be used with caution and stored and handled with care. They may be toxic, harmful, corrosive, irritant or highly flammable and give rise to hazardous fumes and dusts.

The effects of excessive exposure to chemicals may be immediate or delayed; briefly experienced or permanent; cumulative; superficial; life threatening; or may reduce life expectancy.

Chemical Materials - Do's

- Do carefully read and observe hazard and precaution warnings given on material containers (labels) and in any accompanying leaflets, posters or other instructions. Material health and safety data sheets can be obtained from manufacturers.
- Do remove chemical materials from the skin and clothing as soon as practicable after soiling. Change heavily soiled clothing and have it cleaned.
- Do organise work practices and protective clothing to avoid soiling of the skin and eyes.
- Do avoid breathing vapors, aerosols, dusts or fumes; inadequate container labelling; fire and explosion hazards.
- Do wash before job breaks, before eating, smoking, drinking or using toilet facilities when handling chemical materials.
- Do keep work areas clean, uncluttered and free of spills.
- Do store chemical materials according to national and local regulations.
- Do keep chemical materials out of the reach of children.

Chemical Materials - Do Not

- Do Not mix chemical materials except under the manufacturers instructions; some chemicals can form other toxic or harmful chemicals, give off toxic or harmful fumes or become explosive when mixed together.
- Do Not spray chemical materials, particularly those based on solvents, in confined spaces, for example when people are inside a vehicle.

- Do Not apply heat or flame to chemical materials except under the manufacturers instructions. Some are highly flammable and some may release toxic or harmful fumes.
- Do Not leave containers open. Fumes given off can build up to toxic, harmful or explosive concentrations. Some fumes are heavier than air and will accumulate in confined areas such as pits.
- Do Not transfer chemical materials to unlabelled containers.
- Do Not clean hands or clothing with chemicals. Chemicals, particularly solvents and fuels, will dry skin and may cause irritation leading to dermatitis or be absorbed through the skin in toxic or harmful quantities.
- Do Not use emptied containers for other materials except when they have been cleaned under supervised conditions.
- Do Not sniff or smell chemical materials, even brief exposure to high concentrations of fumes can be toxic or harmful.

Corrosion Protection Materials

Some corrosion protection materials are highly flammable – observe NO SMOKING POLICY.

These materials are varied and the manufacturers instructions must always be followed. The materials may contain solvents, resins or petroleum products. Skin and eye contact should be avoided. They should only be sprayed in conditions of adequate ventilation and not in confined spaces.

Dust

Dust or powder produced during repair operations may be irritant, harmful or toxic. Avoid breathing dusts from powdery chemical materials or those arising from dry abrasion operations. Wear respiratory protection if ventilation is inadequate.

Fine dusts of combustible material can present an explosion hazard. Avoid explosive limits and sources of ignition.

Electrical Equipment

Electric shock can result from the use of faulty electrical equipment or from the misuse of equipment in good condition.

Make sure that electrical equipment is maintained in good condition and frequently tested. Faulty equipment should be labelled and preferably removed from the work station.

Make sure that flexes, cables, plugs and sockets are not frayed, kinked, cut, cracked or otherwise damaged. If using cable reel extension equipment, ALWAYS ensure that the cable is fully unwound from the reel.

Make sure that electrical equipment and flexes do not come into contact with water.

Make sure that electrical equipment is protected by the correct rated fuse.

Never misuse electrical equipment and never use equipment which is in any way faulty. The results could be fatal.

Make sure that the cables of mobile electrical equipment cannot get trapped and damaged, such as in a vehicle hoist.

Make sure that the designated electrical workers are trained in basic First Aid.

In cases of electrocution:

- Switch off the power supply before approaching the victim.
- If this is not possible, **DO NOT TOUCH THE VICTIM** but push or drag the person from the source of electricity using dry, non-conductive material.
- Commence resuscitation if trained to do so.
- **SEEK IMMEDIATE MEDICAL ATTENTION.**

Exhaust Fumes

These contain asphyxiating, harmful and toxic chemicals and particles such as carbon oxides, nitrogen oxides, aldehydes, lead and aromatic hydrocarbons. Engines should be run only under conditions of adequate exhaust extraction or general ventilation and not in confined spaces.

Gasoline (Petrol) engine

There may not be adequate warning of odour or of irritation before toxic or harmful effects arise. These may be immediate or delayed.

Gas Oil (Diesel engine)

Soot, discomfort and irritation usually give adequate warning of hazardous fume concentrations.

Fibre Insulation

The fibrous nature of surfaces and cut edges can cause skin irritation. This is usually a physical and not a chemical effect.

Precautions should be taken to avoid excessive skin contact through careful organization of work practices and the use of gloves.

Fire

Many of the materials found on or associated with the repair of vehicles are highly flammable. Some give off toxic or harmful fumes if burnt; others such as fluoroelastomers when burnt or damaged by excessive heat can break down and produce highly corrosive hydrofluoric acid - See Fluoroelastomers.

Should any material be in a burnt or overheated condition, handle with extreme caution and wear protective clothing when handling such items. Dispose of such material in accordance with local regulations.

Decontaminate and dispose of protective clothing immediately after use.

Observe strict fire safety when storing and handling flammable materials or solvents, particularly near electrical equipment or welding processes.

Make sure, before using electrical or welding equipment, that there is no fire hazard present.

Have a suitable fire extinguisher available when using welding or heating equipment.

First Aid

Apart from meeting any legal requirements it is desirable for someone in the workshop to be trained in First Aid procedures.

Splashes in the eye should be flushed carefully with clean water for at least ten minutes.

Soiled skin should be washed with soap and water.

In case of cold burns, from alternative fuels, place affected area in cool to cold water.

Individuals affected by inhalation of gases and fumes should be removed to fresh air immediately. If effects persist, consult a doctor.

If liquids are swallowed inadvertently, consult a doctor giving him the information on the container or label. Do not induce vomiting unless this action is indicated on the label.

Fluoroelastomers (Synthetic Rubber)

Many 'O' rings, seals, hoses, flexible pipes and other similar which appear to be manufactured from natural rubber are, in fact, made of synthetic materials called Fluoroelastomers.

Under normal operating conditions, these materials are safe and do not constitute a health hazard. However, if the materials are damaged by burning or exposure to excessive heat, they can break down and produce highly corrosive hydrofluoric acid.

WARNING: Contact with hydrofluoric acid can cause serious burns on contact with the skin. If skin contact does occur, carry out the following steps immediately:

Remove any contaminated clothing.

SEEK IMMEDIATE MEDICAL ATTENTION

Irrigate affected area of skin with copious amounts of cold water or limewater for 15 to 60 minutes.

Foams - Polyurethane

Used in sound and noise insulation. Cured foams used in seat and trim cushioning.

Unreacted components are irritating and may be harmful to the skin and eyes. Wear gloves and goggles.

Individuals with chronic respiratory diseases, asthma, bronchial medical problems, or histories of allergic diseases should not work in or near uncured materials.

The components, vapors or spray mists can cause direct irritation, sensitivity reactions and may be toxic or harmful.

Vapors and spray mists must not be inhaled. These materials must be applied with adequate ventilation and respiratory protection. Do not remove the respirator immediately after spraying, wait until the vapour/mists have cleared.

Burning of the uncured components and the cured foams can generate toxic and harmful fumes. Smoking, naked flames or the use of electrical equipment during foaming operations and until vapors/mists have cleared should not be allowed. Any heat cutting of cured foams or partially cured foams should be carried out in areas having suitable fume extraction equipment.

Fuels

Avoid skin contact with fuel where possible. Should contact occur, wash the affected skin with soap and water.

Gasoline (Petrol)

Highly flammable - OBSERVE NO SMOKING POLICY.

Swallowing gasoline (petrol) can result in mouth and throat irritation and absorption from the stomach can result in drowsiness and unconsciousness. Small amounts can be fatal to children. Inhalation into the lungs, through vomiting, is a very serious hazard.

Gasoline (petrol) dries the skin and can cause irritation and prolonged or repeated contact may cause dermatitis; if it is allowed to enter the eyes, it will cause severe smarting. Wash affected area with copious amounts of water and **SEEK IMMEDIATE MEDICAL ATTENTION.**

Gasoline (petrol) may contain appreciable quantities of benzene, which is toxic upon inhalation and the concentration of vapors must be kept very low. High concentrations will cause eye, nose and throat irritation, nausea, headache, depression and symptoms of drunkenness. Very high concentrations will result in rapid loss of consciousness.

Make sure there is adequate ventilation when handling and using gasoline (petrol). Great care must be taken to avoid the serious consequences of inhalation in the event of vapour build up arising from spillages in confined spaces.

Special precautions apply to cleaning and maintenance operations on gasoline (petrol) storage tanks.

Gasoline (petrol) should not be used as a cleaning agent. It must not be siphoned by mouth.

Gas-oil (Diesel Fuel)

Combustible.

Prolonged skin contact with high boiling point gas oils (diesel fuel) may cause serious skin disorders including skin cancer.

Inhalation into the lungs will cause internal bleeding **- SEEK IMMEDIATE MEDICAL ATTENTION.**

If swallowed, DO NOT induce vomiting - SEEK IMMEDIATE MEDICAL ATTENTION.

Kerosene (Paraffin)

Used also as heating fuel, solvent and cleaning agent.

Flammable - OBSERVE NO SMOKING POLICY.

Irritation of the mouth and throat may result from swallowing. The main hazard from swallowing arises if liquid aspiration into the lungs occurs.

Liquid contact dries the skin and can cause irritation or dermatitis. Splashes in the eye may be slightly irritating.

In normal circumstances the low volatility does not give rise to harmful vapors. Exposure to mists and vapors from kerosene at elevated temperature should be avoided (mists may arise in dewaxing). Avoid skin and eye contact and make sure there is adequate ventilation.

If swallowed, DO NOT induce vomiting - SEEK IMMEDIATE MEDICAL ATTENTION.

Gas Cylinders

Gases such as oxygen, acetylene, argon and propane are normally stored in cylinders at pressures of up to 138 bar (13800 kPa) (2000 lbf/in²) and great care should be taken in handling these cylinders to avoid mechanical damage to them or to the valve gear attached. The contents of each cylinder should be clearly identified by appropriate markings.

Cylinders should be stored in well ventilated enclosures, and protected from ice and snow or direct sunlight. Fuel gases, for example acetylene and propane should not be stored in close proximity to oxygen cylinders.

Care should be exercised to prevent leaks from gas cylinders and lines and also to avoid sources of ignition.

Only trained personnel should undertake work involving gas cylinders.

General Workshop Tools and Equipment

It is essential that all tools and equipment are maintained in good condition and the correct safety equipment is used where required.

Never use tools or equipment for any purpose other than that for which they were designed. Never overload equipment such as hoists, jacks, axle and chassis stands or lifting slings. Damage caused by overloading is not always immediately apparent and may result in a fatal failure the next time that the equipment is used.

Do not use damaged or defective tools or equipment, particularly high speed equipment such as grinding wheels. A damaged grinding wheel can disintegrate without warning and cause serious injury.

Wear suitable eye protection when using grinding, chiselling or sand blasting equipment.

Wear a suitable breathing mask when using abrasive blasting equipment or using spraying equipment.

Make sure there is adequate ventilation to control dusts, mists and fumes.

High Pressure Air, Lubrication and Oil Test Equipment

Always keep high pressure equipment in good condition, and regularly maintained, particularly at joints and unions.

Never direct a high pressure nozzle, for example diesel injector, at the skin as the fluid may penetrate to the underlying tissue and cause serious injury.

Jacking

Always refer to the Jacking and Lifting section of this manual prior to raising the vehicle off the ground.

When vehicle is to be raised by means of a jack, ensure that it is standing on level ground, that parking brake is applied and wheels are chocked. ALWAYS use the recommended jacking points and ensure that vehicle jack has sufficient load capacity for the weight of the vehicle.

WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Ensure that hoists have sufficient load capacity for the weight of the vehicle.

Legal Aspects

There are many laws and regulations relating to health and safety in the use and disposal of materials and equipment in a workshop.

For a safe working environment and to avoid environmental pollution, workshops should be familiar, in detail, with the many health and safety laws and regulations within their country, published by both national and local authorities.

Lubricants and Greases

Avoid all prolonged and repeated contact with mineral oils. All lubricants and greases may be irritating to the eyes and skin.

Used Engine Oil

Prolonged and repeated contact with engine oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer. Adequate means of skin protection and washing facilities must be provided.

Do not employ used engine oils as lubricants or for any application where appreciable skin contact is likely to occur.

Health Protection Precautions

- Avoid prolonged and repeated contact with oils, particularly used engine oils.
- Wear protective clothing, including impervious gloves where practicable.
- Do not put oily rags into pockets.
- Avoid contaminating clothes, particularly underpants, with oil.
- Heavily soiled clothing and oil-impregnated footwear should not be worn. Overalls must be cleaned regularly.
- First Aid treatment should be obtained immediately for open cuts and wounds.
- Use barrier creams, applying them before each work period, to help the removal of oil from the skin.
- Wash with soap and water to make sure all oil is removed (skin cleansers and nail brushes will help). Preparations containing lanoline replace the natural skin oils which have been removed.
- Do not use gasoline (petrol), kerosene (paraffin), diesel fuel (gas oil), thinners or solvents for cleaning skin.
- If skin disorders develop, obtain medical advice without delay.
- Where practicable, degrease components prior to handling.
- Where there is a risk of eye contact, eye protection should be worn, for example chemical goggles or face shields; in addition an eye wash facility should be provided.

Environmental Precautions

This section provides general information which can help to reduce the environmental impacts from the activities carried out in workshops.

Emissions to air

Many of the activities that are carried out in workshops emit gases and fumes which can contribute to global warming, depletion of the ozone layer and/or the formation of photochemical smog at ground level. By considering how the workshop activities are carried out, these gases and fumes can be minimised, thus reducing the impact on the environment.

Exhaust fumes

Running car engines is an essential part of workshop activities and exhaust fumes need to be ventilated to atmosphere. However, the amount of time engines are running and the position of the vehicle should be carefully considered at all times, to reduce the release of poisonous gases and minimise the inconvenience to people living nearby.

Solvents

Some of the cleaning agents used are solvent based and will evaporate rapidly to atmosphere if used carelessly, or if containers are left unsealed. All containers must be firmly closed when not required and solvent should be used sparingly. Wherever possible, solvents having a low toxicity and flammability should be selected. Always follow the instructions supplied by the solvent manufacturer. Similarly, many paints are solvent based and the spray should be used in such a way as to reduce emissions to a minimum.

Refrigerant

It is illegal to release any refrigerant into the atmosphere. Discharge and replacement of these materials from air conditioning units should only be carried out using the appropriate equipment.

Discharges to water

Most workshops will have two systems for discharging waste water - storm drains and foul drains. Storm drains should only receive clean water i.e. rainwater. Foul drains will accept many of the normal waste water i.e. washing water, detergents and domestic type waste BUT NOT oil, petrol, solvent, acids, hydraulic fluid, antifreeze and similar fluids. If in doubt, always consult the local authority or water company.

Spillages

Every precaution must be taken to prevent spillage of oil, fuel, solvents etc., reaching the drains. All handling of such materials must take place well away from drains and preferably in an area with a suitable containing wall to prevent discharge into drains or watercourses. If a spillage occurs, it must be soaked up immediately using a spill kit where provided.

Checklist

Spillage prevention:

- Store liquids in a secure area.
- Make sure that taps on liquid containers are secure and cannot be accidentally turned on.
- Protect bulk storage tanks from vandalism by locking the valves.
- Transfer liquids from one container to another in an area away from open drains.
- Ensure lids are replaced securely on containers.
- Have spill kits available near to points of storage and liquid handling areas.

Spill Kits

Special materials are available to absorb a number of different substances. They can be in granular form, ready to use and are supplied in suitable containers. Disposal of used spill absorbing material is dealt with in Waste management.

Land contamination

Oils, fuels and solvents etc. can contaminate any soil with which they come into contact. Such materials MUST never be disposed of by pouring on to soil and every precaution must be taken to avoid spillage reaching soil. Waste materials stored on open ground could either leak or have contaminating substances washed off them that would contaminate the land. Always store these materials in suitable skips or similarly robust containers.

Legal compliance

Some sites may have a discharge consent for effluent discharge to the foul drain for a car wash etc. It is essential to know the types of effluent which are allowed to be discharged into the drain and to check the results of any monitoring carried out by the Water Company.

Where paint spraying operations are carried out it may be necessary to apply to the Local Authority for an air emissions licence to operate the plant. If such a licence is necessary, additional precautions will be necessary to comply with the requirements and the results of any air quality monitoring must be checked regularly.

Checklist

Always adhere to the following:

- Know what legal consents and licences apply to the operations.
- Check that the emissions and discharges comply with legal requirements.

Waste Management

Pollution can be reduced by careful handling, storage and disposal of all waste materials that occur on sites. Legislation makes it illegal to dispose of waste materials other than to licensed waste carriers and disposal sites.

This means that it is necessary to not only know what the waste materials are but also to have the necessary documentation and licences.

Handling and storage of waste

Ensure that waste materials are not poured down the drain or on to soil and are stored in such a way that they do not escape on to land or soil.

All waste must be segregated into individual types e.g. oils, metals, batteries, scrap components etc. This will prevent any reaction between different materials and assist in disposal.

Disposal of waste

Dispose of waste in accordance with the following guidelines:

- **Fuel, hydraulic fluid, anti-freeze and oil:** Keep separate and dispose of to specialist contractors.
- **Refrigerant:** Collect in specialist equipment and reuse.
- **Detergents:** Safe to pour down the foul drain if diluted.
- **Paint, thinners:** Keep separate and dispose of to specialist contractor.
- **Components:** Return to supplier for refurbishment or disassemble and reuse any suitable parts. Dispose of remainder in ordinary waste.
- **Small parts:** Reuse any suitable parts, dispose of the remainder in ordinary waste.
- **Metals:** Can be sold if separate from general waste.
- **Tyres:** Keep separate and dispose of to specialist contractor. DO NOT attempt to dispose of tyres by burning.
- **Components/materials containing asbestos:** Keep separate and dispose of to specialist contractor.
- **Oil and fuel wastes (e.g. rags, used spill kit material):** Keep separate and dispose of to specialist contractors.
- **Air filters:** Keep separate and dispose of to specialist contractors.
- **Rubber/plastics:** Dispose of in ordinary waste.
- **Hoses:** Dispose of in ordinary waste.
- **Batteries:** Keep separate and dispose of to specialist contractors.
- **Air bags - DANGER EXPLOSIVES:** Keep separate and dispose of to specialist contractors.
- **Electrical components:** Return to supplier for refurbishment or disassemble and reuse any suitable components. Dispose of remainder in ordinary waste.
- **Catalytic converters:** May be sold if kept separate from general waste.
- **Packaging:** Compact/recycle as much as possible and dispose of in ordinary waste.
- **Office/paper waste:** Recycle paper and toner and ink cartridges, dispose of remainder in ordinary waste.

Noise

Car alarm testing, panel beating, running engines, using air tools etc. are operations which invariably produce a large amount of noise. The location of such activities and also the time of day must be carefully considered having regard to the proximity of houses schools etc.

Some operations may produce high noise levels which could, in time, damage hearing. In these cases, suitable ear protection must be worn.

Solder

Solders are mixtures of metals such that the melting point of the mixture is below that of the constituent metals (normally lead and tin). Solder application does not normally give rise to toxic lead fumes, provided a gas/air flame is used. Oxy-acetylene flames should not be used, as they are much hotter and will cause lead fumes to be produced.

Some fumes may be produced by the application of any flame to surfaces coated with grease, and inhalation of these should be avoided.

Removal of excess solder should be undertaken with care, to make sure that fine lead dust is not produced, which can give toxic effects if inhaled. Respiratory protection may be necessary.

Solder spillage and filings should be collected and removed promptly to prevent general air contamination by lead.

High standards of personal hygiene are necessary in order to avoid ingestion of lead or inhalation of solder dust from clothing.

Solvents

For example acetone, white spirit, toluene, xylene, trichloroethane.

Used in cleaning and dewaxing materials, paints, plastics, resins and thinners.

Some may be highly flammable or flammable.

Skin contact will degrease the skin and may result in irritation and dermatitis following repeated or prolonged contact. Some can be absorbed through the skin in toxic or harmful quantities.

Splashes in the eye may cause severe irritation and could lead to loss of vision.

Brief exposure of high concentrations of vapors or mists will cause eye and throat irritation, drowsiness, dizziness, headaches and, in the worst circumstances, unconsciousness.

Repeated or prolonged exposure to excessive but lower concentrations of vapors or mists, for which there might not be adequate warning indications, can cause more serious toxic or harmful effects.

Aspiration into the lungs, for example through vomiting, is the most serious consequence of swallowing.

Avoid splashes to the skin, eyes and clothing. Wear protective gloves, goggles and clothing if necessary.

Make sure there is good ventilation when in use, avoid breathing fumes, vapors and spray mists and keep containers tightly sealed. Do not use in confined spaces.

When spraying materials containing solvents, for example paints, adhesives, and metal coatings, use extraction ventilation or personal respiratory protection in the absence of adequate general ventilation.

Do not apply heat or flame except under specific and detailed manufacturers instructions.

Suspended Loads

CAUTION: Never improvise lifting tackle.

There is always a danger when loads are lifted or suspended. Never work under an unsupported, suspended or raised load, for example a suspended engine.

Always make sure that lifting equipment such as jacks, hoists, axle stands and slings are adequate and suitable for the job, in good condition and regularly maintained.

Viton

In common with many other manufacturers vehicles, some components installed to Land Rover vehicles have seals, 'O' rings or gaskets which contain a material known as 'Viton'.

Viton is a fluoroelastomer, that is a synthetic rubber type which contains Fluorine. Although Viton is the most well known fluoroelastomer, there are others, including Fluorel and Tecmoflon.

When used under design conditions fluoroelastomers are perfectly safe. If, however, they are exposed to temperatures in excess of 400°C, the material will not burn, but will decompose, and one of the products formed is hydrofluoric acid.

This acid is extremely corrosive and may be absorbed directly, through contact, into the general body system. **WHERE CASES OF SKIN CONTACT OCCUR, SEEK IMMEDIATE MEDICAL HELP.**

O-rings, seals or gaskets which have been exposed to very high temperatures will appear charred or as a black sticky substance.

DO NOT, under any circumstances touch them or the attached components.

Enquiries should be made to determine whether Viton or any other fluoroelastomer has been used in the affected O-ring, seal or gasket. If they are of natural rubber or nitrile there is no hazard. If in doubt, be cautious as the material may be Viton or any fluoroelastomer.

If Viton or any other fluoroelastomers have been used, the affected area should be decontaminated before the commencement of work.

Disposable heavy duty plastic gloves should be worn at all times, and the affected area washed down using wire wool and a limewater (calcium hydroxide) solution to neutralise the acid before disposing of the decomposed Viton residue and final cleaning of the area. After use, the plastic gloves should be discarded carefully and safely.

Welding

Welding processes include Resistance Welding (Spot Welding), Arc Welding and Gas Welding.

Resistance Welding

This process may cause particles of molten metal to be emitted at a high velocity, and the eyes and skin must be protected.

Arc Welding

This process emits a high level of ultra-violet radiation which may cause arc-eye and skin burns to the operator and to other persons nearby. Gas-shielded welding processes are particularly hazardous in this respect. Personal protection must be worn, and screens used to shield other people.

CONTACT LENS WEARERS ARE ADVISED TO REVERT TO ORDINARY SPECTACLES WHEN ARC WELDING as the arc spectrum is believed to emit microwaves which dry out the fluid between the lens and the eye. This may result in blindness when the lens is removed from the eye.

Metal spatter will also occur, and appropriate eye and skin protection is necessary.

The heat of the welding arc will produce fumes and gases from the metals being welded, the rods and from any applied coatings or contamination on the surfaces being worked on. These gases and fumes may be toxic and inhalation of these should be avoided. The use of extraction ventilation to remove the fumes from the working area may be necessary particularly in cases where the general ventilation is poor, or where considerable welding work is anticipated. In extreme cases or confined spaces where adequate ventilation cannot be provided, air-fed respirators may be necessary.

CAUTION: Some of the components installed to the vehicle e.g. the interior cross beam and underbonnet cross member are manufactured from magnesium alloy. On no account should any welding operations be attempted on these components.

Gas Welding (and Cutting)

Oxy-acetylene torches may be used for welding and cutting, and special care must be taken to prevent leakage of these gases, with consequent risk of fire and explosion.

The process will produce metal spatter and eye and skin protection is necessary.

The flame is bright, and eye protection should be used, but the ultra-violet emission is much less than that from arc welding, and lighter filters may be used.

The process itself produces few toxic fumes, but such fumes and gases may be produced from coatings on the work, particularly during cutting away of damaged body parts, and inhalation of the fumes should be avoided.

In brazing, toxic fumes may be produced from the metals in the brazing rod, and a severe hazard may arise if brazing rods containing cadmium are used. In this event particular care must be taken to avoid inhalation of fumes and expert advice may be required.

SPECIAL PRECAUTIONS MUST BE TAKEN BEFORE ANY WELDING OR CUTTING TAKES PLACE ON VESSELS WHICH HAVE CONTAINED COMBUSTIBLE MATERIALS, FOR EXAMPLE BOILING OR STEAMING OUT OF FUEL TANKS.

Warning Symbols on Vehicles

Decals showing warning symbols will be found on various vehicle components.

These decals must not be removed. The warnings are for the attention of owners/operators and persons carrying out service or repair operations on the vehicle.

General Information - Special Tool Glossary

Description and Operation

Service Tools

Special service tools have been developed to facilitate removal, dismantling and assembly of mechanical components in a cost effective and time efficient manner. The use of such special tools also helps prevent the potential for damage to components.

Some operations described in this manual cannot be carried out properly without the aid of the relevant service tools.

All orders and enquiries from the United Kingdom and European countries except Germany, Austria, Switzerland and Spain and countries not in the following list should be sent direct to:

SPX UK Ltd.,

Genoa House,

Everdon Park,

Daventry,

Northants,

NN11 5YJ

England

Tel: 0044 (0) 1327 303467/303455

Fax: 0044 (0) 1327 706632

e-mail: spxsalesuk@servicesolutions.spx.com

Overseas orders for the following countries should be placed with the local distributor.

Germany, Austria and Switzerland

SPX Europe GMBH,

Porschestrasse 4,

63512 Hainburg,

Germany

Tel: 0049 61829590

Fax: 0049 6182959299

Spain

SPX Iberica SA,

C/Francisco Aritio,

158 nave 72 (Nudo Oeste),

19004 Guadalajara,

Spain

Tel: 0034 949208381

Fax: 0034 949208327

North America

SPX Corporation

665, Eisenhower Drive,

Owatonna,

MN 55060,

USA

Tel: 0018 772979110

Fax: 0018 005787375

Australia

SPX Australia,

28, Clayton Road,

Notting Hill,

Victoria 3168,

Australia

Tel: 0061 00395446222

Fax: 0061 00395445222

e-mail: sales@spx.com.au

Japan and East Asia

Jatek Ltd.,

5 - 53, Minawacho 2-chome,

Kohoku-ku,

Yokohama,

Kanagawa 223-0051,

Japan

Tel: 0081 455627700

Fax: 0081 455627800

Identification Codes - Identification Codes

Description and Operation

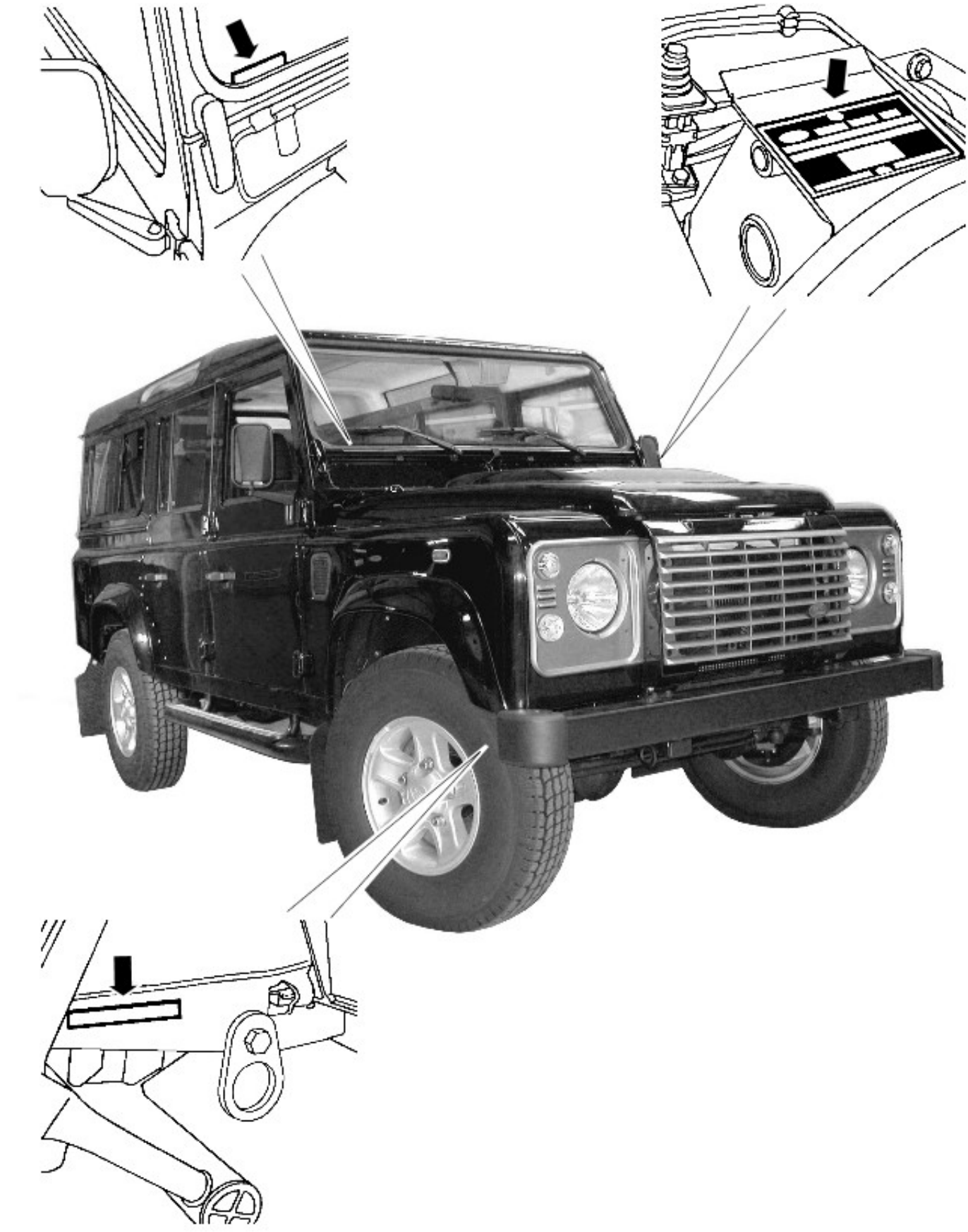
VIN Number

The VIN number is found in three locations:

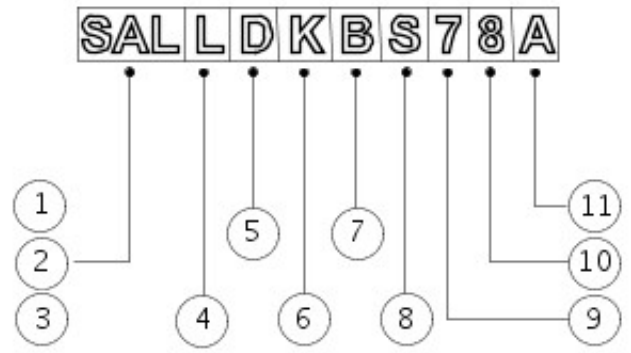
1. Stamped on the RH side of the chassis towards the rear of the front lashing eye.

2. At the bottom of the windshield glass on the RH side of the vehicle and is visible from the outside.

3. On a plate attached to the brake pedal box in the engine compartment.



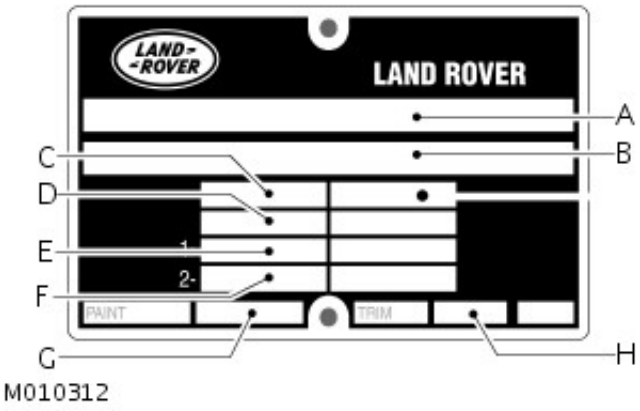
E91212



E91381

VIN Position	Character	Identifies
1 - 3 - World identifier	SAL	Land Rover (UK)
4,5 - Vehicle type	LD	Defender
6 - Class	H	110 inch
6 - Class	K	130 inch
6 - Class	V	90 inch
6 - Class	B	110 Extra heavy duty
7 - Body style	A	Regular
7 - Body style	B	3 Door station wagon
7 - Body style	F	4 Door Crew Cab non h/cap
7 - Body style	H	H/cap with or without 4 door crew cab
7 - Body style	M	4 Door Station Wagon
8 - Engine	S	2.4L Euro spec (EU4)
8 - Engine	T	2.4L ROW spec (non cat)
9 - Transmission and steering	7	RHD 6 speed manual transmission
9- Transmission and steering	8	LHD 6 speed manual transmission
10 - Model year	7	2007 Model year
10 - Model year	8	2008 Model year
10 - Model year	9	2009 Model year
11 - Plant	A	Solihull
11 - Plant	C	Zimbabwe
11 - Plant	F	KD
11 - Plant	J	Malaysia
11 - Plant	K	Kenya
11 - Plant	P	Pakistan
11 - Plant	W	Turkey

Vehicle Identification Plate



M010312

The VIN plate contains the following information:

A - Type approval number

B -Vehicle identification number

C - Maximum permitted laden weight for vehicle

D - Maximum vehicle and trailer weight

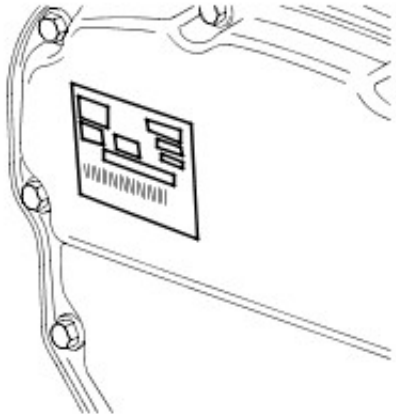
E - Maximum road weight - front axle

F - Maximum road weight - rear axle

G - Paint code

H - Trim level

Unit/Assembly Serial Number Locations

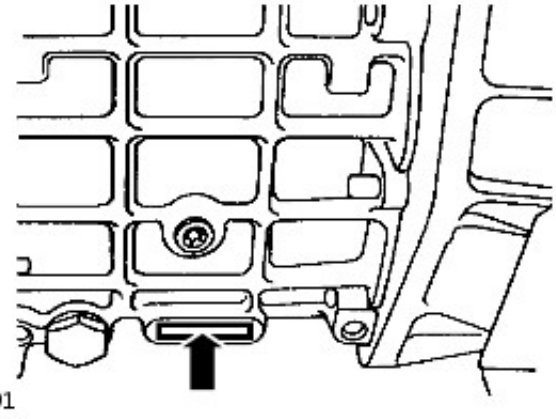


TIE0031810

Engine Identification Label

- Date and time of manufacture
- Engine part number

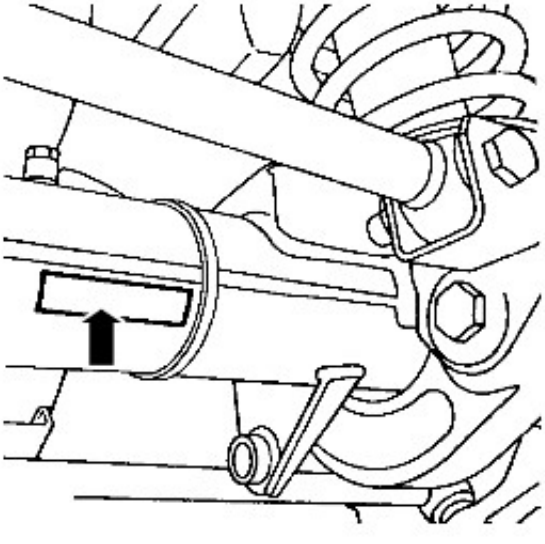
Manual Transmission Serial Number



J6091

The Manual Transmission Serial Number is stamped on a cast pad on the bottom RH side of the transmission casing.

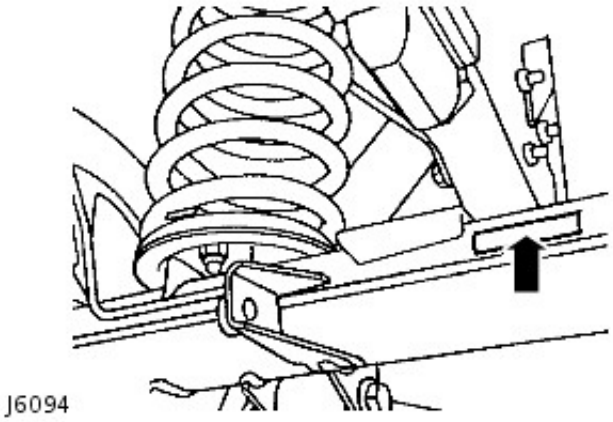
Front Axle Serial Number



J6093

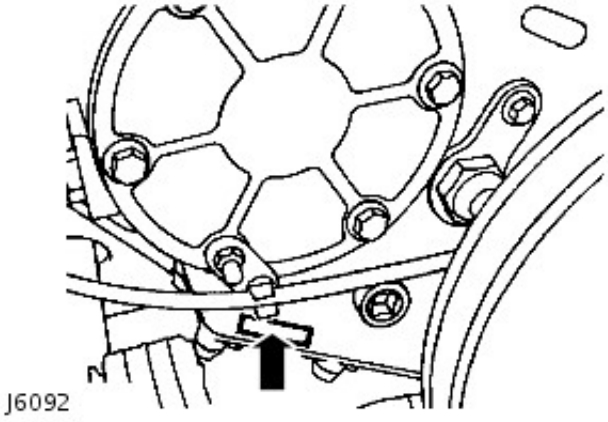
The front axle serial number is stamped on the LH side of the front axle tube, inboard of radius arm mounting bracket.

Rear Axle Serial Number



The rear axle serial number is stamped on the rear axle tube on the LH side, inboard of the spring mounting.

Transfer Case Serial Number



The transfer case serial number is stamped on the LH side of the transfer case below the mainshaft rear bearing housing adjacent to the bottom cover.

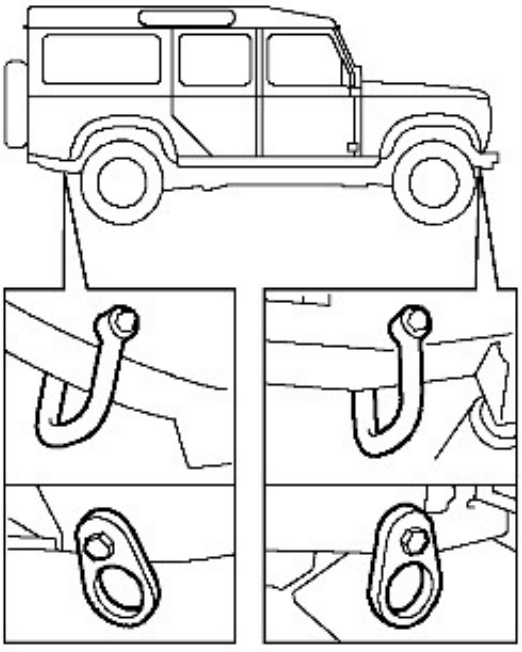
Jacking and Lifting - Vehicle Recovery

Description and Operation

CAUTION: The vehicle has permanent four-wheel drive. The following towing instructions must be adhered to:

Towing the vehicle on all four wheels with driver operating steering and brakes.

- Turn ignition key to position '1' to release steering lock.
- Select neutral in main gearbox and transfer gearbox.



J6085

- Secure tow rope, chain or cable to front towing eyes (alternative types shown).
- Release the parking brake.

CAUTION: The brake booster and power assisted steering system will not be functional without the engine running. Greater pedal pressure will be required to apply the brakes, the steering system will require greater effort to turn the front road wheels. The vehicle tow connection should be used only in normal road conditions, 'snatch' recovery should be avoided.

Transporting the vehicle by trailer

Lashing/towing eyes are provided on front and rear of the chassis side members, see J6085, to facilitate the securing of the vehicle to a trailer or other means of transportation.

CAUTION: Underbody components must not be used as lashing points.

Install vehicle on trailer and apply park brake. Select neutral in main gearbox.

Rear suspended tow by breakdown vehicle

- If the front axle is to be trailed turn ignition key to position '1' to release steering lock.
- Select neutral in main gearbox and transfer box.
- The steering wheel and/or linkage must be secured in a straight ahead position. DO NOT use the steering lock mechanism for this purpose.

Jump starting

WARNING: Hydrogen and oxygen gases are produced during normal battery operation. This gas mixture can explode if flames, sparks or lighted tobacco are brought near battery. When charging or using a battery in an enclosed space, always provide ventilation and shield your eyes.

Keep out of reach of children. Batteries contain sulphuric acid. Avoid contact with skin, eyes, or clothing. Also, shield eyes when working near battery to protect against possible splashing of acid solution. In case of acid contact with skin, eyes, or clothing, flush immediately with water for a minimum of fifteen minutes. If acid is swallowed, drink large quantities of milk or water, followed by milk of magnesia, a beaten egg, or vegetable oil.

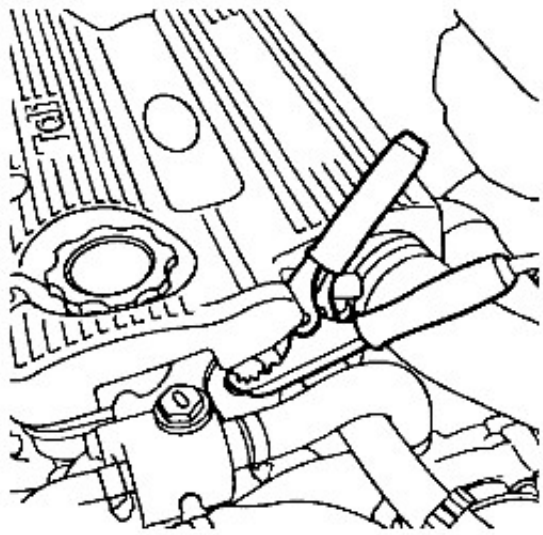
SEEK MEDICAL AID IMMEDIATELY.

To Jump Start - Negative Ground Battery

WARNING: To avoid any possibility of injury use particular care when connecting a booster battery to a discharged battery.

- Position vehicles so that jump leads will reach, ensuring that vehicles DO NOT TOUCH, alternatively a fully charged slave battery may be positioned on floor adjacent to vehicle.
- Ensuring that ignition and all electrical accessories are switched off, that parking brake is applied and neutral is selected, connect the jump leads as follows;

A. Connect one end of first jumper cable to positive (+) terminal of booster battery. B. Connect other end of first jumper cable to positive (+) terminal of discharged battery. C. Connect one end of second jumper cable to negative terminal of booster battery. D. Connect other end of second jumper cable to a good earth point on the disabled vehicle (eg. engine front lifting eye, as shown in J6086), NOT TO NEGATIVE TERMINAL OF DISCHARGED BATTERY. Keep jumper lead away from moving parts, pulleys, drive belts and fan blade assembly.



J6086

WARNING: Making final cable connection could cause an electrical arc which if made near battery could cause an explosion.

- If booster battery is installed in another vehicle, start engine and allow to idle.
- Start engine of vehicle with discharged battery, following starting procedure in Owners' Manual.

CAUTION: If vehicle fails to start within a maximum time of 12 seconds, switch ignition off and investigate cause. Failing to follow this instruction could result in irrepairable damage to catalyst, if fitted.

- Remove negative (-) jumper cable from the engine and then terminal of booster battery.
- Remove positive (+) jumper cable from positive terminals of booster battery and discharged battery.

Jacking and Lifting - Jacking
Description and Operation

General

WARNING: The following instructions must be adhered to before raising the vehicle off the ground:

- Position vehicle on a solid, level surface.
- Apply the parking brake.
- Select 'P' - PARK on automatic transmission selector or 1st gear on manual transmission and 'H' High on transfer case.
- Select low range in the transfer box.

CAUTION: To avoid damage occurring to the under body components of the vehicle the following jacking procedures must be adhered to.

DO NOT POSITION JACKS OR AXLE STANDS UNDER THE FOLLOWING COMPONENTS.

- **Body structure**
- **Bumpers**
- **Fuel lines**
- **Brake lines**
- **Front radius arms**
- **Panhard rod**
- **Steering linkage**
- **Rear trailing links**
- **Fuel tank**
- **Engine sump**
- **Gearbox bell housing**

Vehicle jack

The jack provided with the vehicle is only intended for use in an emergency such as changing a tire. DO NOT use the jack for any other purpose. Refer to the Owner's Handbook for the vehicle jack location points and jacking procedures.

WARNING: Never work under a vehicle supported solely by the vehicle jack.

Hydraulic jack

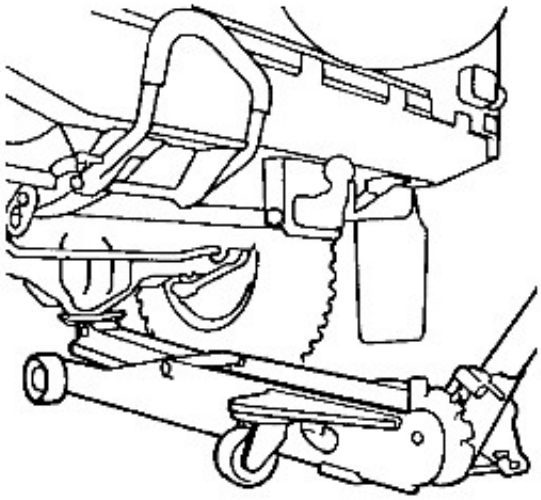
A hydraulic jack with a minimum lifting capacity of 1500 kg, (3,300 lbs) must be used.

• WARNINGS:

Do not commence work on the underside of the vehicle until suitable axle stands have been placed in the correct position.

Always chock the wheels when jacking. The parking brake may be ineffective when the wheel(s) are off the ground.

Raising the Front of the Vehicle



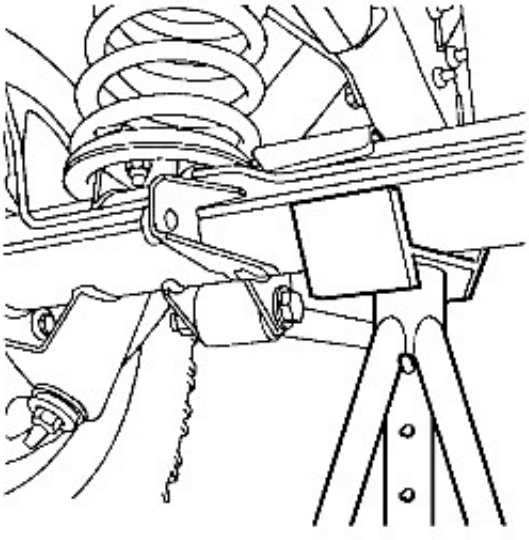
J6083

- Position cup of hydraulic arm under differential casing.

• NOTE: The differential casing is not central to the axle. Care should be taken when raising the front road wheels off the ground as the rear axle has less sway stiffness.

- Raise front road wheels to enable an axle stand to be installed under left hand axle tube.
- Position an axle stand under right hand axle tube, carefully lower jack until axle sits securely on both axle stands, remove trolley jack.
- Before commencing work on underside of vehicle re-check security of vehicle on stands.
- Reverse procedure when removing vehicle from stands.

Raising the Rear of the Vehicle



J6084

- Position cup of hydraulic arm under differential casing.
- Raise vehicle to enable axle stands to be installed under left and right hand axle tubes.
- Lower jack until axle sits securely on axle stands, remove trolley jack.
- Before commencing work on underside of vehicle re-check security of vehicle on stands.
- Reverse procedure when removing vehicle from stands.

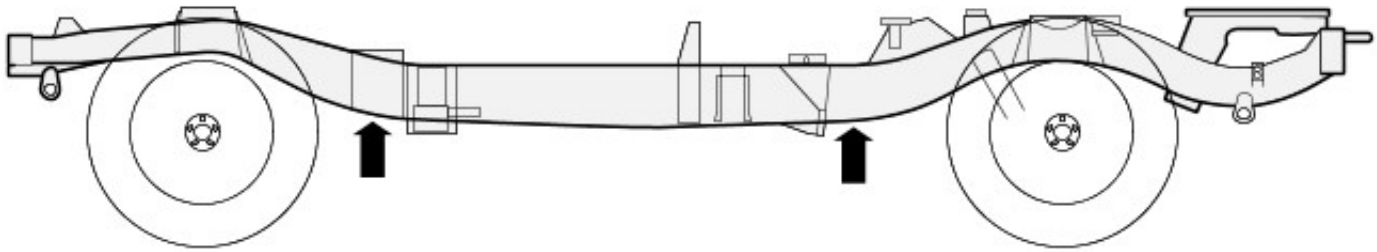
Jacking and Lifting - Lifting
Description and Operation

Four post vehicle ramps

Position the vehicle on the ramp with the front and the rear of the vehicle equidistant from the ends of the ramp. Chock the wheels, select neutral on the transmission and where practicable apply the parking brake.

If a wheel free condition is required, use a wheel-free system which supports beneath the axle casings.

Two post vehicle ramps



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WARNING: When raised to the desired height, make sure the vehicle is stable before starting work.

CAUTION: If the drive shafts are to be disconnected, release the parking brake and select neutral on the transmission in order that the shaft(s) can be rotated when the vehicle is raised to the desired height.

- Position the vehicle with the centre of the lifting pillars aligned with the front of the driver/passenger seat cushions.
- Extend the lifting arms and position the pads of each lifting arm beneath the body frame longitudinal lifting points, arrowed in the illustration.
- Raise the vehicle until the wheels are just clear of the ground and check that the pads of each lifting arm are still correctly positioned and are in full contact with the body frame longitudinals.
- Raise the vehicle to the desired height.
- Ensure that the vehicle is correctly supported on all four lifting pads, that the pads are still correctly positioned and are in full contact with the body frame longitudinals.

Road roller testing

Four wheel Rolling Road

WARNING: DO NOT attempt to drive individual wheels with vehicle supported on floor jacks or stands.

Provided that front and rear rollers are rotating at identical speeds and that normal workshop safety standards are applied, there is no speed restriction during testing except any that may apply to the tyres.

Two wheel rolling road

IMPORTANT: Use a four wheel rolling road for brake testing if possible.

If brake testing on a two wheel rolling road is necessary, it must be carried out with propeller shaft to the stationary axle removed and neutral selected in BOTH main gearbox and transfer gearbox. When checking brakes, run engine at idle speed to maintain brake servo vacuum.

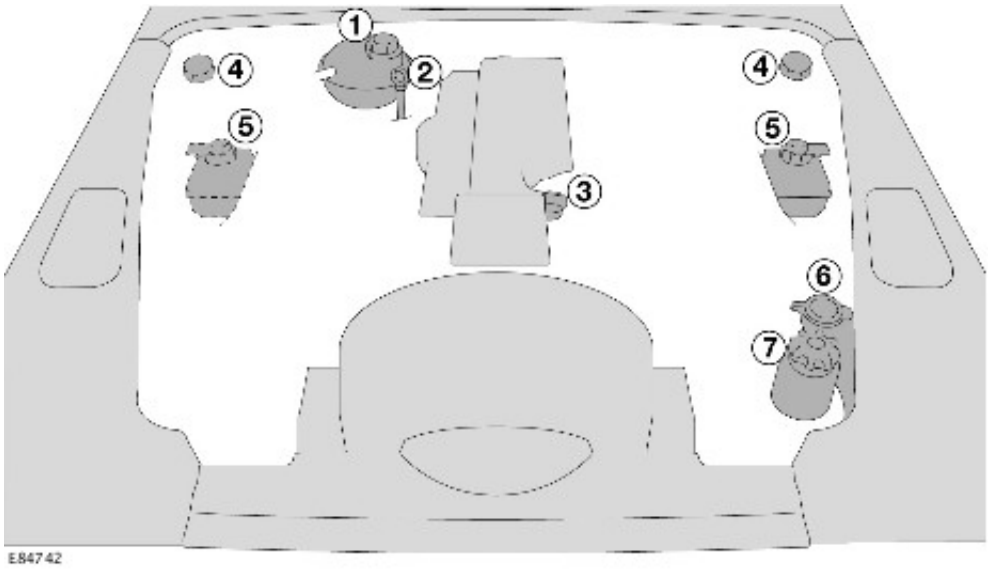
Maintenance Schedules - Maintenance Schedules - Diesel Engines

Description and Operation

Torque Specifications

Description	Nm	lb-ft
Wheel nuts - steel wheels	100	80
Wheel nuts - alloy wheels	130	96
Wheel nuts - Heavy duty wheels	170	125
Transfer box filler plug	30	22
Transfer box drain plug	30	22

Under Bonnet View



Item	Part Number	Description
1	-	Coolant expansion tank
2	-	Engine oil dipstick
3	-	Engine oil filler cap
4	-	Clutch fluid reservoir filler cap
5	-	Brake fluid reservoir filler cap
6	-	Windscreen washer reservoir
7	-	Power steering fluid reservoir

Seats and Safety Belts

1. Check seat frames are secured to floor and show no signs of movement.

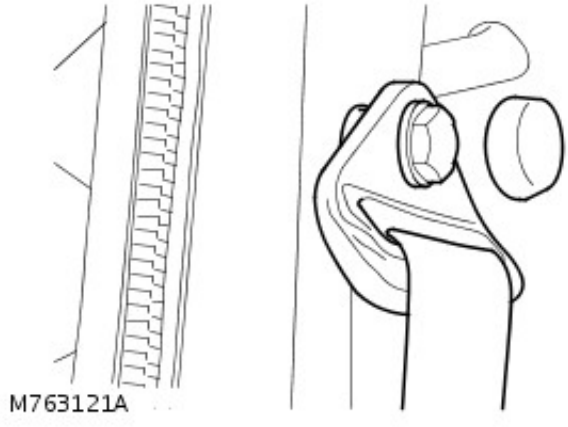
2. Check operation of seat slide and tilt mechanisms, making sure there is no excessive play between seat cushion and seat back.

3. Check tightness of accessible seat fixings.

4. Fully extract seat belt and allow it to return under its own recoil mechanism.

5. Check entire length of seat belt webbing for signs of fraying or damage. Repeat for all belts.

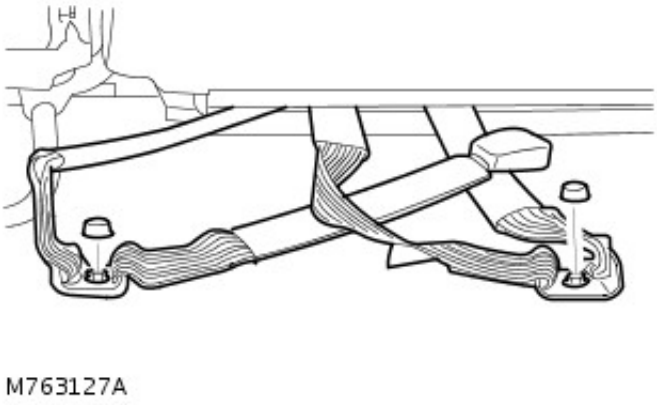
6.Check security of seat belt upper mountings.



7. Check security of seat belt buckle mountings.

8. Connect each belt to the correct buckle, check seat belt buckle and tongue are secure. Release seat belt buckle and check for correct operation.

9. Check tightness of accessible seat belt mountings



Lamps, Horns and Warning Indicators

1. Check side, head, fog, reversing and tail lamps for correct operation.

2. Check operation of headlamp automatic levelling system - if installed.

3. Check turn signals and hazard warning lamps for correct operation.

4. Check brake (stop) lamps for correct operation.

5. Check all exterior lamp lenses for clarity and condition; pay particular attention to headlamp and fog lamp lenses for stone chips or damage.

6. Check horn for loud, clear sound.

7. Switch on headlamps and check that side/headlamp reminder warning sounds when door is opened.

8. Check operation of interior courtesy lamps.

9. Check operation of all instrument pack warning and indicator lamps.

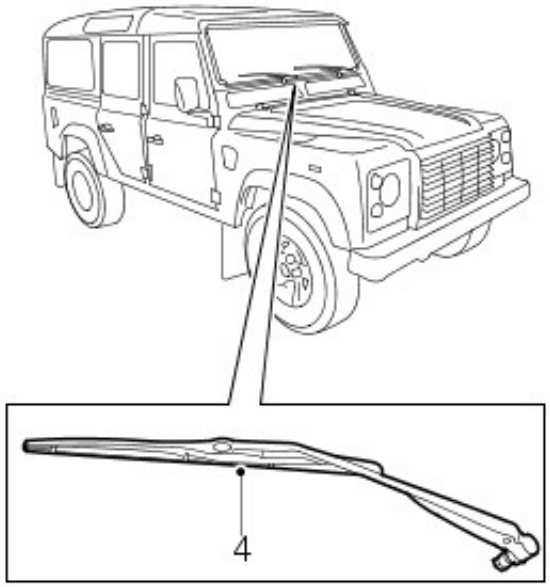
Washers and Wipers

1. Operate screen washer and switch on wipers. Check washer jets are correctly aimed and check for smooth seamless operation across screen of wiper blades at all speeds, including intermittent.

2. Repeat operation for rear screen wipers and washers.

3. Check all wiper blades for condition and signs of splits or damage.

4. Check security of wiper arms.



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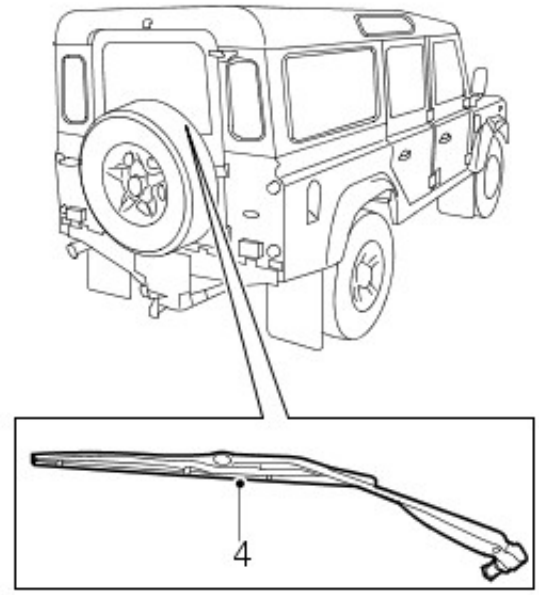

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Parking Brake

1. With the vehicle stationary, apply the parking brake and check for correct operation.
For additional information, refer to: Parking Brake Shoe and Lining Adjustment (206-05 Parking Brake and Actuation, General Procedures).

Release parking brake and check for correct operation.

Battery Condition

• NOTE: The vehicle may be fitted with an alarm and immobilisation system. To prevent the alarm from sounding, it is important that the following procedure is used when disconnecting the battery.

1. Remove drivers seat base.

2. Release clip securing battery cover.

3. Remove battery cover.

4. Turn the ignition switch to position 'II', and then to position '0'.

5. Remove the ignition key.

• NOTE: Always disconnect the -ve terminal first. When replacing, connect the +ve terminal first.

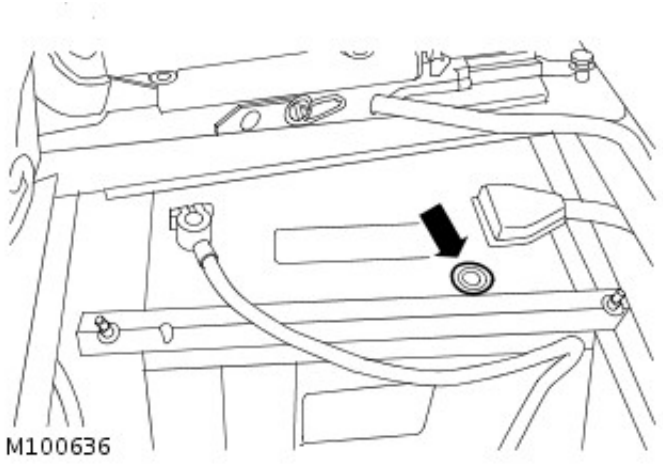
6. Disconnect the vehicle -ve terminal within 15 seconds.

7. The battery is designed to be maintenance free, topping-up is not possible. On the top of the battery is a battery

indicator. When the indicator shows:

- GREEN - The battery is in a good state of charge.
- DARK (turning to black) - The battery needs charging.
- CLEAR (or light yellow) - The battery needs replacing. Do not charge the battery or jump start the vehicle in this condition.
- If the green dot is missing, the battery needs charging.

• NOTE: If the indicator shows clear or yellow, tap the indicator with the handle of a screwdriver to disperse any air bubbles. If the indicator colour remains unchanged, the battery will need replacing.



8. Clean and grease battery terminals and leads with petroleum jelly.

9. Connect leads to battery (+ve first) and tighten clamp bolts.

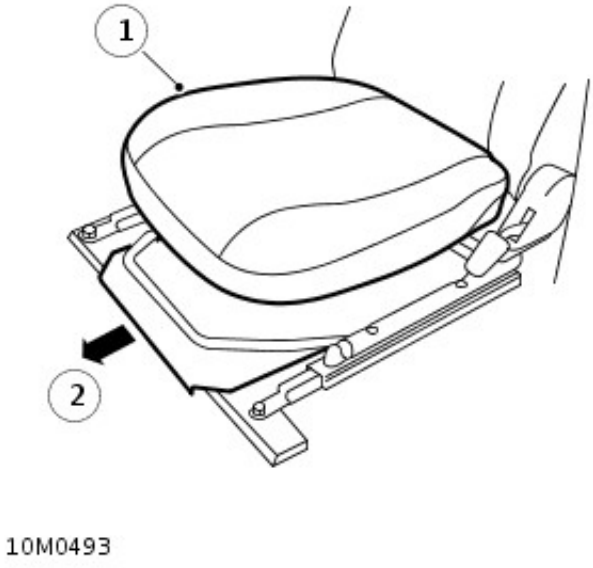
10. Fit battery cover and secure with clip.

11. Fit drivers seat base.

Clean Battery Terminals

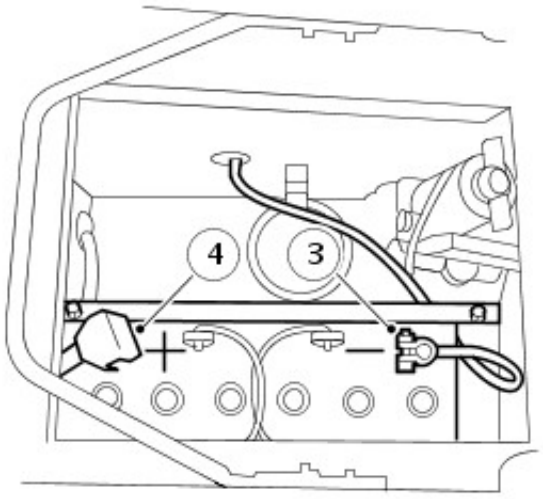
1. Remove drivers seat base.

2. Release clip securing battery cover. Remove battery cover.



3. Disconnect both battery terminals, -ve terminal first. Clean off corrosion and neutralise. Smear terminals with petroleum jelly.

4. Reconnect battery terminals +ve first, when maintenance operations have been completed.



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5. Fit battery cover and secure with clip.

6. Fit drivers seat base.

Handset Battery

• NOTE: Do not remove a battery until you are ready to install the replacement. Always fit a Land Rover STC4080 or a Panasonic CR2032 replacement battery.

1. Unlock the vehicle and disarm the alarm system.

2. Turn the ignition switch to position 'II', then turn to position '0' and remove the key.

CAUTION: Do not allow moisture to get inside the handset.

3. Carefully prise the handset apart, starting from the keying end. Avoid damaging the seal between the two halves of the case.

4. Slide the battery out of its clip, taking care to avoid touching the circuit board or the contact surfaces of the clip.

5. Press and hold one of the buttons for at least 5 seconds to drain any residual power from the handset.

6. Fit the new battery, making sure that correct polarity is maintained (+ve side facing up). Finger marks will adversely affect battery life. Avoid touching the flat surfaces of the battery, and wipe clean before fitment.

7. Reassemble the two halves of the handset. Operate the Padlock symbol button at least 4 times within range of the vehicle to resynchronise the handset.

Headlamp Alignment

1. Check alignment of headlamps.
For additional information, refer to: Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).

Road Wheels

1. Loosen wheel nuts. Raise vehicle for wheel free condition and remove the wheel nuts.

2. Mark the wheel to stud relationship to make sure that the wheels are refitted in the same orientation.

3. Apply a thin coat of anti-seize compound to wheel hub centre.

• NOTE: When refitting road wheel nuts do not over tighten using powered tools. Make sure the wheel nuts are correctly tightened in the correct sequence.

4. Refit wheels to original hub position.

5. Tighten wheel nuts.

- Steel wheels - 100 Nm (80 lbf/ft)
- Alloy wheels - 130 Nm (96 lbf/ft)
- Heavy Duty wheels - 170 Nm (125 lbf/ft)

Tire Pressures, Condition and Tread Depth

1. Check for any apparent damage to tires, paying particular attention to side walls.

• NOTE: Any adjustments to steering or suspension will be subject to additional labour and/or material cost and should not be carried out without the authorisation of the customer.

2. Look at tires treads and check for any unusual wear patterns which may indicate out of specification adjustment of steering or suspension.

• NOTE: Any requirement to replace tires should be advised to the customer before any remedial work is carried out. This will be subject to additional labour and/or material cost and should not be carried out without the authorisation of the customer.

3. Measure the tread depth across the width of the tire and around the circumference. Annotate the maintenance check sheet with the lowest figure obtained from each tire.

Brake Pads, Calipers and Discs

1. With front road wheels removed, check brake pad thickness and make sure that both pads are wearing evenly.

• NOTE: Any requirement to replace brake pads or brake disc should be advised to the customer as this will incur additional labour and/or material cost and should not be carried out without the authorisation of the customer.

2. Check brake discs for signs of cracking, excessive scoring or oil contamination.

3. Check for any signs of brake fluid leakage from caliper seals, hoses or unions.

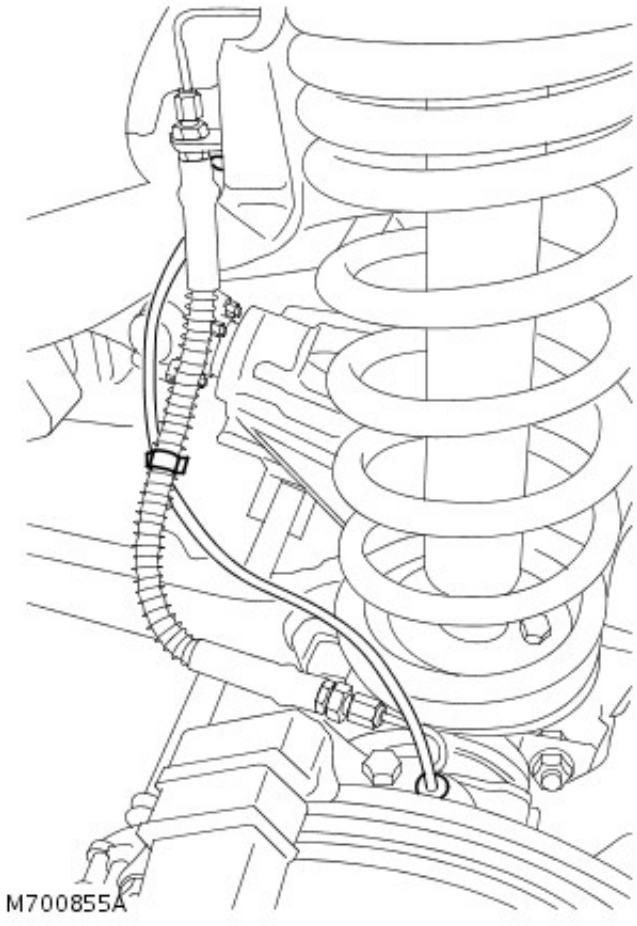
4. Using brake cleaner, remove excessive deposits of brake dust from pads, calipers and disc shields.

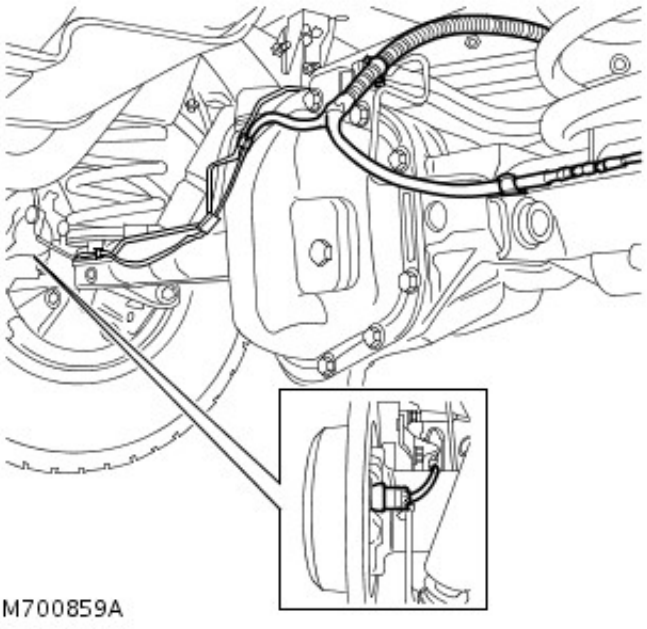
Road Wheel Speed Sensor Harness

1. Check each road wheel speed sensor harness is correctly and securely routed.

• NOTE: Any requirement to replace a road wheel speed sensor should be advised to the customer as this will incur additional labour and/or material cost and should not be carried out without the authorisation of the customer.

2. Inspect each harness for chafing or damage.





Fuel Filter

WARNING: Fuel vapour is highly flammable and in contained spaces is also explosive and toxic. Always have a fire extinguisher containing FOAM, CO2, GAS OR POWDER close at hand when handling or draining fuel.

Replace fuel filter.
For additional information, refer to: Fuel Filter (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

Charge Air Cooler

1. Visually check for any obstructions in the radiator and charge air cooler matrix and remove debris as necessary.

2. Visually check fan blades for damage.

3. Check cooling, charge air cooler and heating systems for leaks, hoses and oil pipes for security and condition.

4. Check accessible hose clips for tightness.

5. Check coolant level, top-up if necessary

Charge Air Cooler Flush

1. Remove charge air cooler.
For additional information, refer to: Charge Air Cooler (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

2. Flush charge air cooler element using Unicorn Chemicals 'C' Solve following the manufacturers instructions.

3. Thoroughly dry charge air cooler and making sure that no trace of solvent remains in the element.

4. Install charge air cooler.
For additional information, refer to: Charge Air Cooler (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

Cooling System Top-Up

1. With engine cold, remove expansion tank filler cap.

2. Top-up with recommended mixture of coolant until level reaches mark on expansion tank.

3. Fit expansion tank filler cap.

Coolant Renew

1. Renew engine coolant.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

2. Fit expansion tank filler cap.

1. Open each door in turn and lubricate door hinges and check strap using recommended lubricant.

2. Lubricate door lock, striker and private lock using PTFE lubricant. Remove excessive lubricant, particularly from door striker area, to avoid customer complaint.

3. Check tightness of accessible door lock and striker fixings

4. Open and close door to check for smooth, noise-free operation. Make sure door closes securely.

5. Check for smooth operation of private lock.

6. With bonnet open, lubricate hinges, striker, lock and safety catch using a suitable lubricant.

Air Cleaner Element

1. Replace air cleaner element.
For additional information, refer to: Air Cleaner Element (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

Accessory Drive Belt

Check accessory drive belt for signs of splits, fraying, oil contamination and wear.

• NOTE: Any requirement to replace the accessory drive belt should be advised to the customer as this will incur additional labour and/or material cost and should not be carried out without the authorisation of the customer.

1. Renew a damaged or contaminated accessory drive belt.

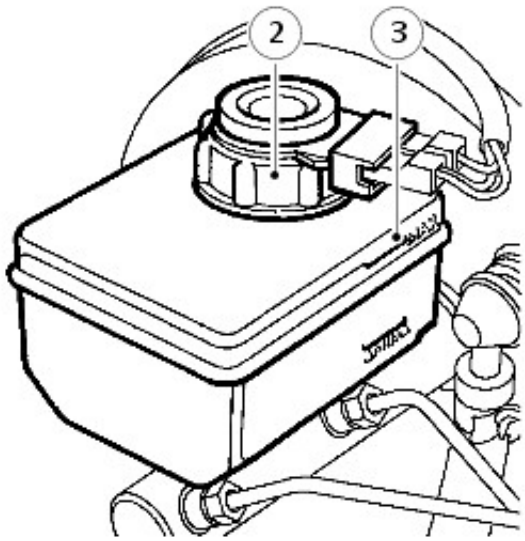
Fluid Levels

Brake Fluid Reservoir

1. Check the fluid level visually through transparent side of reservoir without removing cap.

2. If level is below ''**MAX'** mark clean the area around the reservoir filler cap and remove cap.

3. Top up to**'MAX'** mark with recommended brake fluid.
For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).

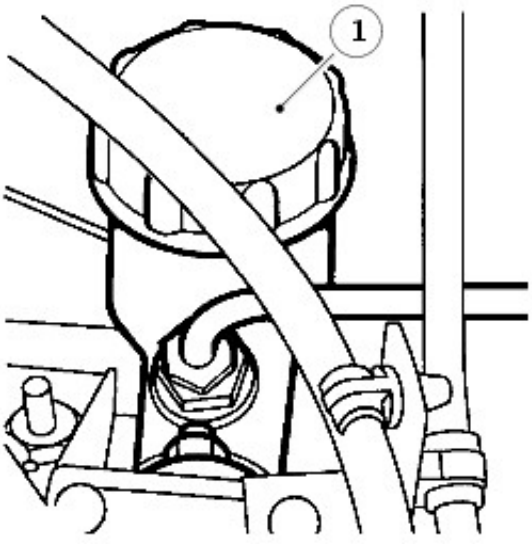


J6103

4. Reinstall the reservoir filler cap.

Clutch Fluid Reservoir

1. Clean area around clutch fluid reservoir cap, and remove cap.



J6102

2. Check fluid level in clutch fluid reservoir.

3. Clean the area around the reservoir filler cap, remove the cap.

4. If necessary, top-up using the recommended fluid to the **'MAX'** mark on the reservoir.
For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).

5. Reinstall the reservoir filler cap.

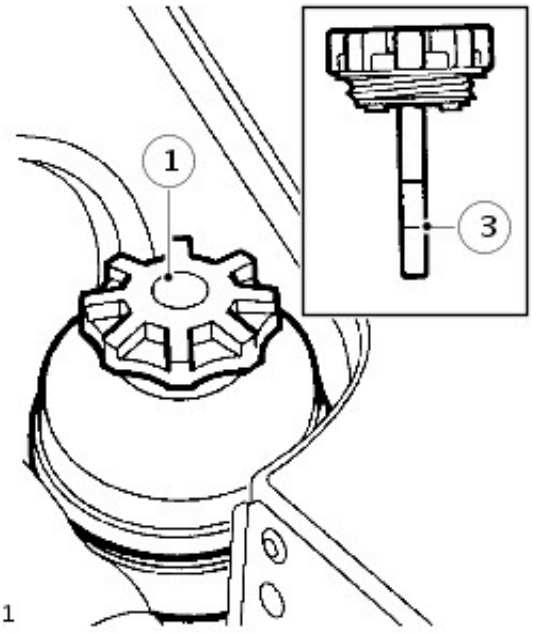
Power Steering Fluid

CAUTION: To prevent over filling, check/top-up the system with the engine switched off and the system cold. Make sure that the steering wheel is in the straight ahead position, do not turn the steering wheel prior to checking the fluid level.

1. Check that the fluid level is to the mid-way mark between the **'MAX'** and **'MIN'** marks on the fluid reservoir, top-up if necessary.

2. Clean the area around the reservoir filler cap, remove the cap.

3. If necessary, top-up using the recommended fluid to the mid-way mark on the reservoir.
For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).



J6101

CAUTION: **Do not fill reservoir above the 'MAX' mark.**

4. Reinstall the reservoir filler cap.

Windshield Washer Reservoir

1. Remove the windshield washer reservoir filler cap.

2. Top-up the reservoir using a mixture of an approved windshield washer fluid and water until the level is to the bottom of the reservoir filler neck.

3. Reinstall the reservoir filler cap.

Engine Oil and Filter

1. Renew engine oil and filter.
For additional information, refer to: Engine Oil Draining and Filling (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Steering Box

1. Check steering box for leaks.

2. Check there is no backlash in steering box with the road wheels in the straight ahead position. Adjust if necessary.
For additional information, refer to: Steering Gear Adjustment (211-00 Steering System - General Information, General Procedures).

Manual Gearbox Oil

WARNING: Avoid excessive skin contact with used gearbox oil. Used gearbox oil contains potentially harmful contaminants which may cause skin cancer or other serious skin disorders.

1. Renew gearbox oil.
For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

Transfer Case Oil

Check and Top-Up

WARNING: Avoid excessive skin contact with mineral oil. Mineral oils remove the natural fats from the skin, leading to dryness, irritation and dermatitis.

CAUTION: The transfer case oil filler plug must not be used as a transfer case oil level plug. Failure to follow this instruction may result in damage to the vehicle.

1. Drain and measure the transfer case oil.For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures). **2.** Refill the transfer case with the recommended oil.For additional information, refer to: Specifications (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

Transfer Case Oil Replace

WARNING: Avoid excessive skin contact with mineral oil. Mineral oils remove the natural fats from the skin, leading to dryness, irritation and dermatitis.

1. Renew transfer case oil.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

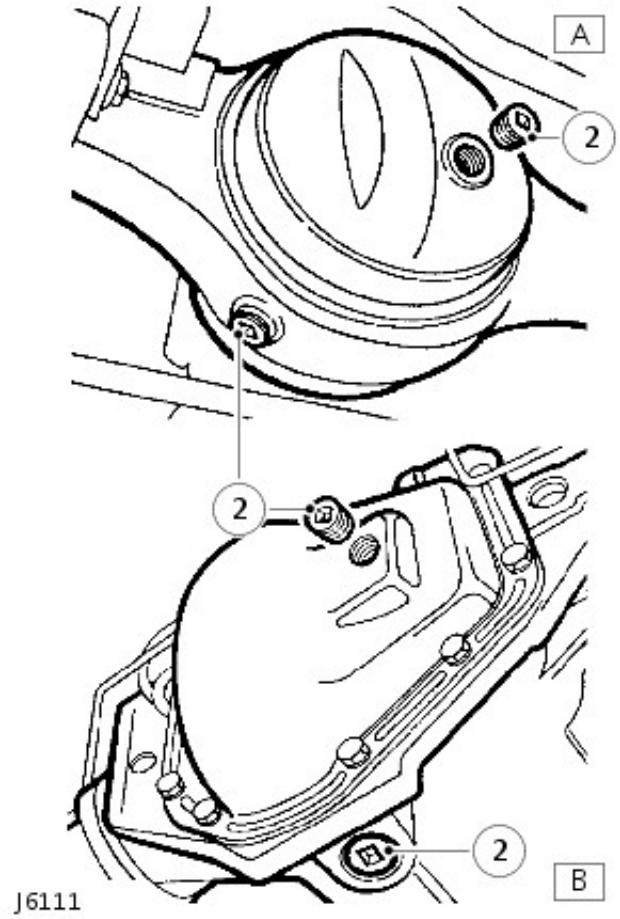
Front and Rear Axles

Check

WARNING: Avoid excessive skin contact with used axle oil. Used axle oil contains potentially harmful contaminants which may cause skin cancer or other serious skin disorders.

1. Make sure vehicle is level.

2. Using 13 mm square drive wrench, remove filler/level plug.



Item	Part Number	Description
A	-	Front and rear axle - 90 models; Front - 110/130 models
B	-	Rear axle - 110/130 models

3. If necessary inject new oil until oil runs out from filler/level hole. Allow excess oil to drain and wipe clean.
For additional information, refer to: Specifications (205-02 Rear Drive Axle/Differential, Specifications).

4. Clean and refit filler/level plug.

Replace

WARNING: Avoid excessive skin contact with used axle oil. Used axle oil contains potentially harmful contaminants which may cause skin cancer or other serious skin disorders.

1. Make sure vehicle is level and place suitable tray under axle to be drained.

2. Using 13mm square drive wrench, remove drain and filler/level plugs from axle and allow oil to drain completely.

3. Clean and refit drain plug.

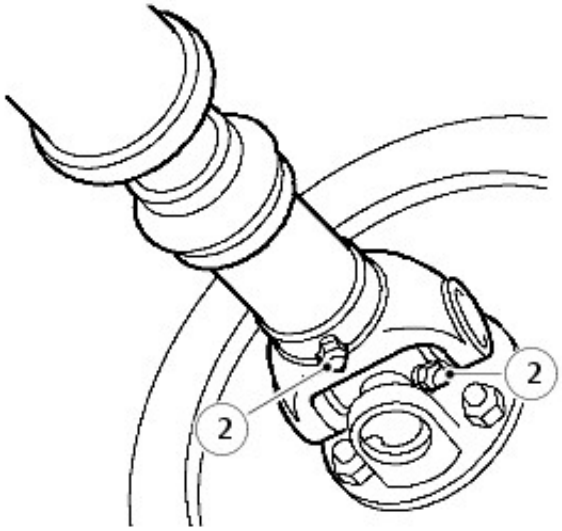
4. Inject new oil, until it runs out from filler/level hole. Allow excess oil to drain and wipe clean.

5. Clean and refit filler/level plug.

Drive Shafts

1. Clean area around front universal joint grease nipple.

2. Apply recommended grease to the grease nipple.



J6113

Clutch Pipes and Unions

1. Check clutch pipes and unions for chafing, leaks and corrosion.

Power Steering Pipes and Unions

1. Check clutch pipes and unions for chafing, leaks and corrosion.

Engine, Gearbox, Transfer Case and Axles

1. Check for oil leaks from Engine, Gearbox, Transfer box, and axles. Pay particular attention to areas around oil seals.

Exhaust System

1. Visually check condition of exhaust system for signs of damage.

2. Check condition of exhaust heat shields.

3. Check exhaust system is firmly secured and check condition of exhaust mounting rubbers, clamps and brackets.

Steering Box and Suspension

1. Check steering box fixings.
For additional information, refer to: Specifications (204-00 Suspension System - General Information, Specifications).

2. Check LH and RH front radius arm fixings. Tighten if necessary.
For additional information, refer to: Specifications (204-00 Suspension System - General Information, Specifications).

3. Check Panhard rod fixings. Tighten if necessary.
For additional information, refer to: Specifications (204-00 Suspension System - General Information, Specifications).

4. Check all rear axle fixings. Tighten if necessary.
For additional information, refer to: Specifications (205-02 Rear Drive Axle/Differential, Specifications).

Steering Ball Joints

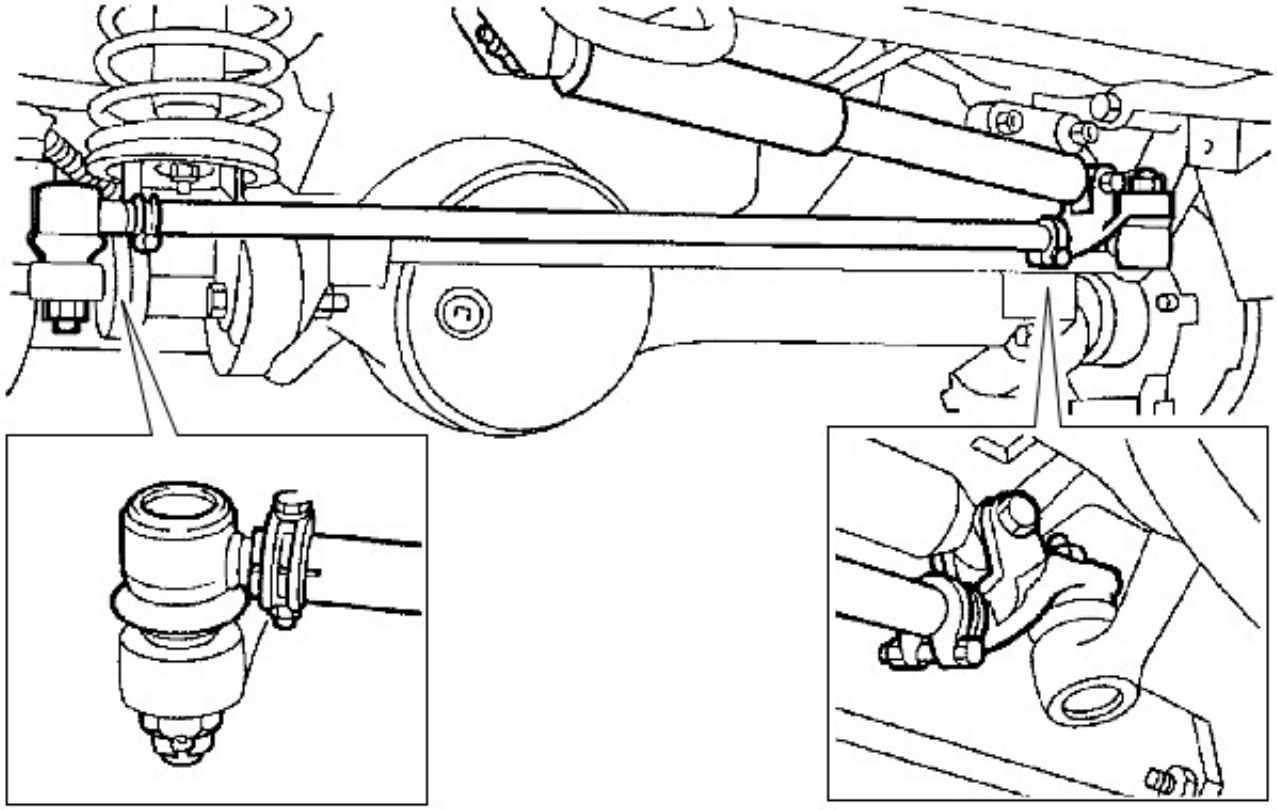
1. Check for wear in joints by attempting to move the joint from side to side and backwards and forwards. If free movement is apparent, fit a new joint assembly.

CAUTION: Do not check for wear by having an assistant move the steering wheel from side to side while observing the joint.

2. Check condition of steering ball joints paying particular attention to dust covers.

• NOTE: Any requirement to replace the steering ball joints should be advised to the customer as this will incur additional labour and/or material cost and should not be carried out without the authorisation of the customer.

• NOTE: Ball joints are lubricated for life during manufacture and require no further lubrication unless the rubber boot has been dislodged or damaged. All joints should be checked at specified service intervals, but more frequently if vehicle is used under arduous conditions.



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Shock Absorbers

1. Check for signs of leakage from suspension dampers.

2. Check for signs of suspension damper damage.

Towing Bracket

1. Check security of towing bracket.

Engine and Transmission Mountings

1. Check condition of front LH engine mounting. Tighten fixings if necessary.
For additional information, refer to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

2. Check condition of front RH engine mounting. Tighten fixings if necessary.
For additional information, refer to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

3. Check condition of rear LH gearbox mounting. Tighten fixings if necessary.
For additional information, refer to: Specifications (308-03 Manual Transmission/Transaxle, Specifications).

4. Check condition of rear RH gearbox mounting. Tighten fixings if necessary.
For additional information, refer to: Specifications (308-03 Manual Transmission/Transaxle, Specifications).

Road Test

WARNING: Two wheel roller tests where rollers are driven by the vehicle MUST NOT be carried out. For details of rolling road testing,

1. Check for correct operation of starter switch. Make sure the engine starts in a correct manner. Leave the engine running.

2. With vehicle stationary, turn steering from lock to lock. Check for smooth operation and make sure there is no undue noise from the power steering pump or drive belt.

3. Depress clutch and select all gears in turn. Check for smooth notch free engagement.

4. Drive vehicle on a short road test. Check all vehicle systems for correct operation. Pay particular attention to:

- Manual gear selection.
- Gear selection/noise - high/low range.
- Steering for abnormal noise/effort.
- Steering for free play.
- Engine noise
- Gearbox noise or vibration
- Suspension noise or irregularities
- Body noise
- Braking system operation
- Engine performance
- Excessive exhaust smoke.
- All instruments, gauges and warning indicators.
- Heater and air conditioning systems.
- Fully extend seat belt, check operation of retraction and latching. Inertia belts lock when snatched or vehicle on slope.
- Seat reclining and latching.

5. Check for correct operation of all instruments and warning devices where practical.

6. After road test, carry out a final inspection of the vehicle on vehicle ramps.

7. Check all underbonnet fluid levels and top-up if necessary.

General

1. Endorse Service Record.

2. Report any unusual features of vehicle condition and any additional work required.

2: Chassis

Suspension System - General Information -

Suspension	
90	
Front	Live beam axle, linear rate coil springs, coaxial telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by fabricated steel Panhard rod and longitudinal axle location by forged steel radius arms. Stabilizer bar if alloy wheels fitted.
Rear	Live beam axle, linear rate coil springs (dual rate for heavy duty derivative), telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by forged steel 'A' frame arms and longitudinal axle location by fabricated steel trailing links. Stabilizer bar if alloy wheels fitted.
110	
Front	Live beam axle, dual rate coil springs, coaxial telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by fabricated steel Panhard rod and longitudinal axle location by forged steel radius arms. Stabilizer bar if station wagon or crew cab derivative.
Rear	Live beam axle, triple rate coil springs, telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by forged steel 'A' frame arms and longitudinal axle location by fabricated steel trailing links. Stabilizer bar if station wagon or crew cab derivative.
110 heavy duty and 130	
Front	Live beam axle, linear rate coil springs, coaxial telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by fabricated steel Panhard rod and longitudinal axle location by forged steel radius arms. Stabilizer bar.
Rear	Live beam axle, triple rate coil springs, coaxial linear rate helper springs, telescopic nitrogen-charged hydraulic shock absorbers. Lateral axle location by forged steel 'A' frame arms and longitudinal axle location by fabricated steel trailing links. Stabilizer bar.

Road spring data

Road spring	Part number	Colour code
90 2 seat utility (2400 Kg)		
Front - Driver's side	REB500200	Red/green/white
Front - Passenger side	REB500220	Red/green/orange
Rear - Driver's side	NRC 9448	Blue/red
Rear - Passenger side	NRC 9449	Yellow/white
90 2 seat utility (2550 Kg)		
Front - Driver's side	REB500200	Red/green/white
Front - Passenger side	REB500220	Red/green/orange
Rear - Driver's side	RKB101230	Green/yellow/red
Rear - Passenger side	RKB101240	Green/yellow/white
90 4 seat station wagon (2400 Kg)		
Front - Driver's side	REB500200	Red/green/white
Front - Passenger side	REB500220	Red/green/orange
Rear - Driver's side	RKB500290	Red/green/green
Rear - Passenger side	RKB500280	Red/green/red
90 4 seat station wagon (2550 Kg)		
Front - Driver's side	REB500200	Red/green/white
Front - Passenger side	REB500220	Red/green/orange
Rear - Driver's side	RKB500270	White/green/pink
Rear - Passenger side	RKB500310	White/green/purple
LHD 110 2 seat utility, 5 seat station wagon and 5 seat crew cab (3050 Kg)		
Front - Driver's side	NRC 8044	White/white
Front - Passenger side	NRC 8045	Yellow/yellow
Rear - Both sides	RKB101111	Purple/brown
RHD 110 2 seat utility, 5 seat station wagon and 5 seat crew cab (3050 Kg)		
Front - Both sides	NRC 8045	Yellow/yellow
Rear - Both sides	RKB101111	Purple/brown
LHD 110 7 seat station wagon (3050 Kg)		
Front - Driver's side	NRC 8044	White/white
Front - Passenger side	NRC 8045	Yellow/yellow
Rear - Both sides	RKB500300	White/green/green
RHD 110 7 seat station wagon (3050 Kg)		
Front - Both sides	NRC 8045	Yellow/yellow
Rear - Both sides	RKB500300	White/green/green
110 heavy duty and all 130 (3500Kg)		
Front - Driver's side	NRC 9448	Blue/red
Front - Passenger side	NRC 9449	Yellow/white
Rear - Both sides	RKB101111	Purple/brown

Rear helper springs - Both sides	RRC 3266	No colour code

Torque values - front suspension

	Nm
Drag link ball joint nut	40 + tighten to next castle slot on nut
Tie rod ball joint nut	40 + tighten to next castle slot on nut
Securing ring for mounting turret	14
Panhard rod to axle	230
Panhard rod to chassis bracket	230
Panhard rod chassis bracket to chassis	123
Radius arm to axle	210
Radius arm to chassis	176
Shock absorber (upper and lower mountings)	38
Bump stop to chassis frame	22
Stabilizer bar to stabilizer link	75
Stabilizer link to axle	40 + tighten to next castle slot on nut
Stabilizer bar to chassis bracket	45
Tie bar to Panhard rod mounting bracket	85
Tie bar to steering box	85

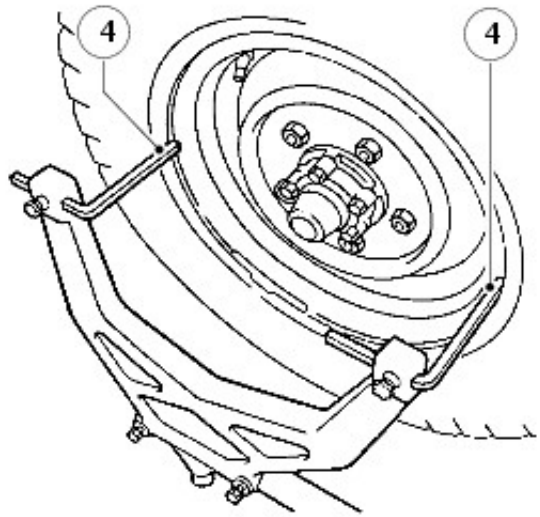
Torque values - Rear suspension

	Nm
Trailing link to chassis bush	176
Trailing link to chassis	62
Trailing link to axle	176
'A' frame ball joint to axle	176
'A' frame to ball joint	115
'A' frame to chassis bracket	
Vehicles fitted with ¾ inch UNF bolts	176
Vehicles fitted with M16 bolts	150
'A' frame to chassis bracket to chassis (if applicable)	63
Shock absorber to axle	38
Shock absorber to shock absorber upper mounting bracket	75
Shock absorber upper mounting bracket to chassis	44
Stabilizer bar to stabilizer link	75
Stabilizer link to axle	40 + tighten to next castle slot on nut
Stabilizer bar bush bracket to chassis	22
Bump stop to chassis frame	22

Suspension System - General Information - Front Toe Adjustment

General Procedures

• NOTE: Recognised front wheel alignment and tracking equipment should be used for this operation. Only the use of basic equipment is described below. No adjustment is provided for castor, camber or swivel pin inclinations.



J6296

1. Set vehicle on level ground with road wheels positioned straight ahead.

2. Push vehicle back and forwards to settle linkage.

3. Set up the equipment to manufacturers instructions and check alignment as advised by equipment supplier.

4. Position trammel probes on inner face of wheel, not the rims, if the latter are damaged.

5. Measure toe-out at horizontal centre-line of wheels.

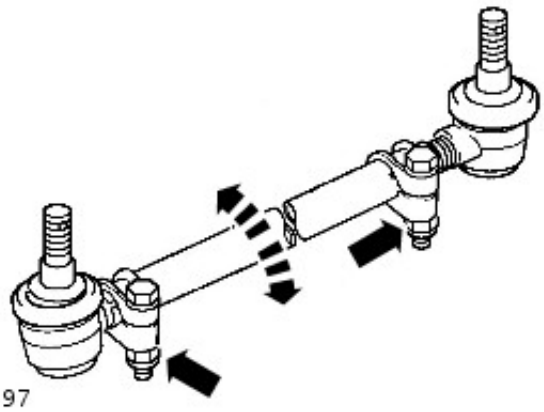
6. Check tightness of clamp bolt fixings. Tighten to 14 Nm (10lbf/ft).

7. Slacken clamps at both ends of track rod.

8. Rotate track rod to increase or decrease its effective length until correct toe-out is obtained.
For additional information, refer to: Specifications (211-00 Steering System - General Information, Specifications).

9. Push vehicle rearwards turning steering wheel from side to side to settle ball joints. With road wheels set in straight ahead position, push vehicle forward a short distance.

10. Recheck track and adjust if necessary.



J6297

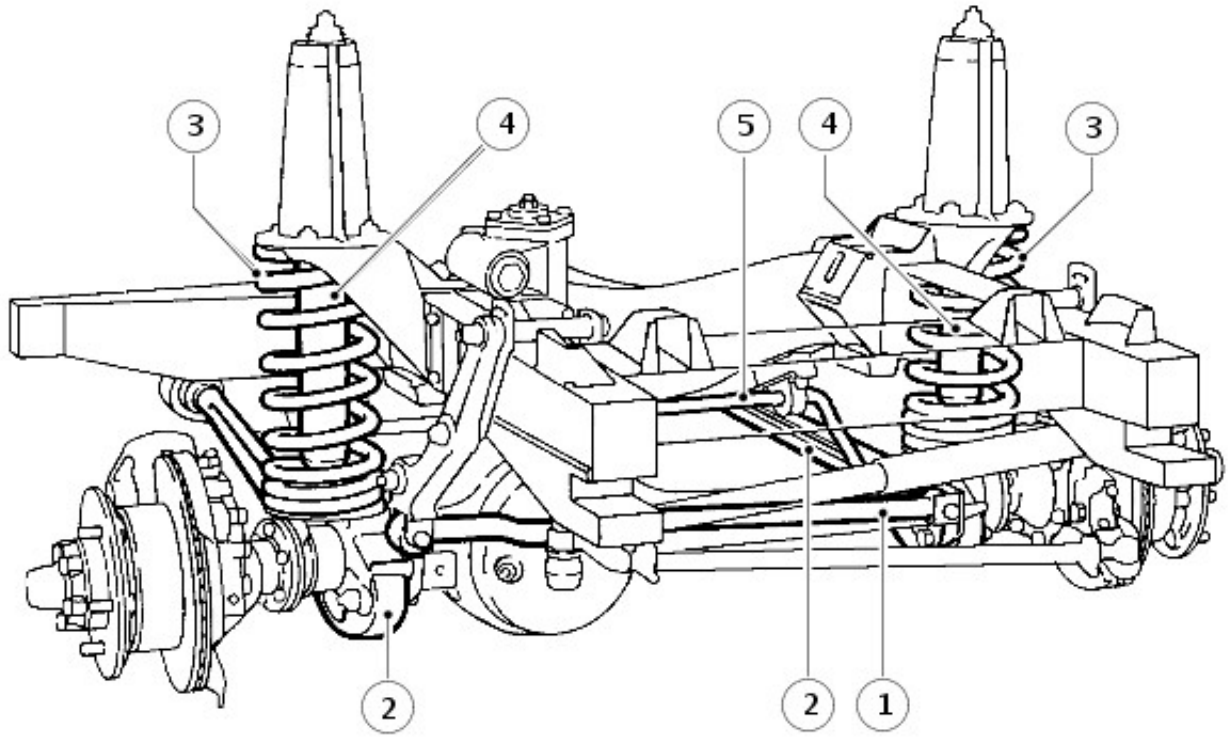
11. When alignment is correct, tap ball joints in direction of arrows to maximum of travel, to ensure full unrestricted movement of track rod.

12. Tighten clamp bolts to 14 Nm (10 lbf/ft).

Front Suspension - Front Suspension

Description and Operation

Front suspension



J6268

Item	Part Number	Description
1	-	Panhard rod
2	-	Radius arms
3	-	Coil springs
4	-	Shock absorbers
5	-	Stabilizer bar

Description

The front suspension design allows maximum wheel travel and axle articulation providing good ground clearance without loss of traction or directional stability.

Long radius arms are fitted to the front axle and provide maximum axle articulation which is vital for off road performance. The radius arms are secured to fabricated mounting brackets welded to the front axle. Flexible rubber bushes are used on a stem end joint to secure the rear of the radius arms to mountings on the chassis cross member.

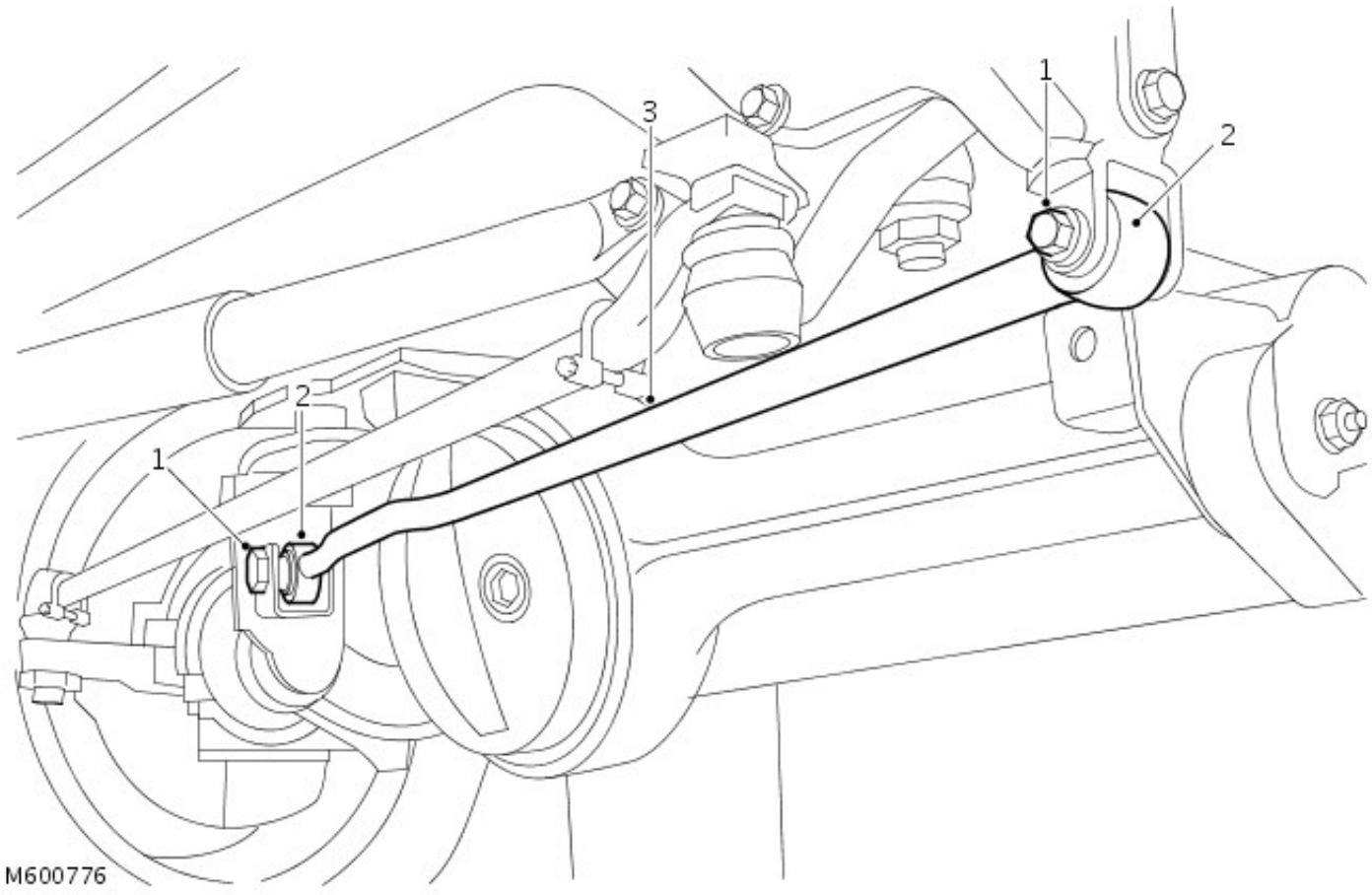
A Panhard rod, which ensures that the front axle remains centrally located, is fitted transversely and also uses ferrule rubber bush mountings at both axle and chassis locations.

Two rubber bearing bushes, with retaining straps, secure the rear of the stabilizer bar to the chassis mountings, while bushed links support the front of the bar to the front axle.

Conventional long travel coil springs and hydraulic shock absorbers are used to control body movement in all conditions. The shock absorbers are secured to fabricated towers which are bolted to the chassis. The upper and lower fixings use a single location stud with flexible rubber bushes, support washers and securing nuts. Retaining plates are used to secure the coil springs to the fabricated towers and axle mountings.

Rubber bump stops are fitted underneath the chassis, adjacent to the front road springs, and prevent possible damage that could occur should there be excessive axle to chassis movement.

Front suspension 02MY



Item	Part Number	Description
1	-	Bolts
2	-	Bushes
3	-	Panhard rod

Changes have been incorporated to improve the durability of the suspension. The current Panhard rods are forged. New Panhard rods are introduced which are fabricated from tubular steel and are handed.

The rods are fitted with larger bushes which use M16 bolts in place of the M14 bolts. The torque for the new bolts is raised to 230 Nm (170 lbf.ft).

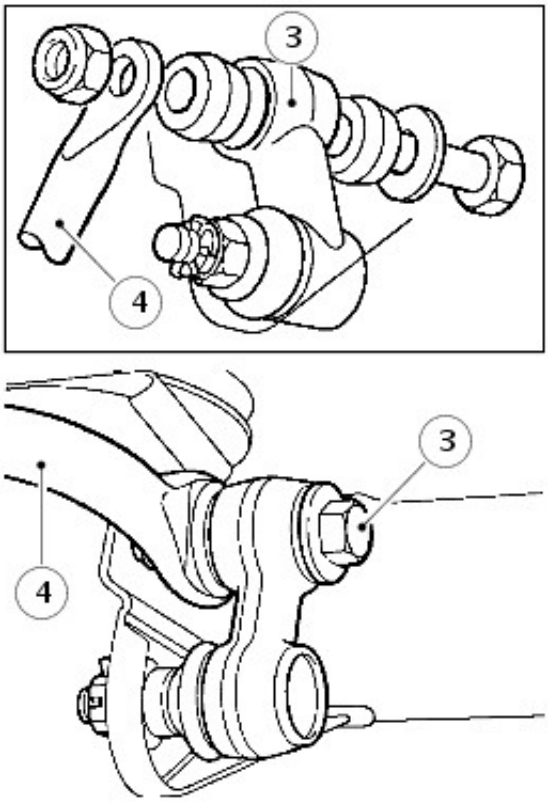
The Panhard rod support brackets are now fabricated from upgraded steel which allows the higher torque figure to be applied to the fixing bolts.

Front Suspension - Front Stabilizer Bar

Removal and Installation

Removal

1. Mark for reassembly position of rubber bushes on stabilizer bar.
2. Remove 4 nuts, bolts and washers securing both stabilizer bar bush straps to chassis mounting brackets.
3. Remove nuts, bolts, washers and rubber bushes securing stabilizer bar to both links
4. Remove stabilizer bar.



J6258

Installation

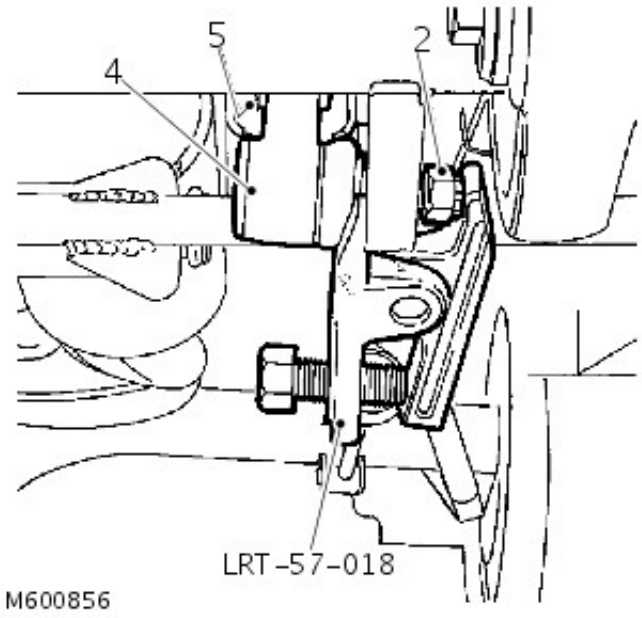
1. Position bushes on stabilizer bar. Ensure split points towards axle on RH bush and away from axle on LH bush.
2. Instal stabilizer bar with two straps. To ensure correct fit angled sides of bar should point down. Loosely instal the bolts, washers and nyloc nuts.
3. Instal bolt, washers and rubber bushes. Using new nuts fit stabilizer bar to links and tighten to 68Nm (50 lbf.ft).
4. Tighten nuts securing straps to 30Nm (22lbf.ft).

Front Suspension - Front Stabilizer Bar Link

Removal and Installation

Removal

1. Raise vehicle on ramp.
2. Remove 2 nuts, bolts, washers and rubber bushes from ball joint links.
3. Remove cotter pin and loosen castellated nut a few turns.
4. Release link joint using tool LRT-57-018 as shown.
5. Remove castellated nut and link.



Installation

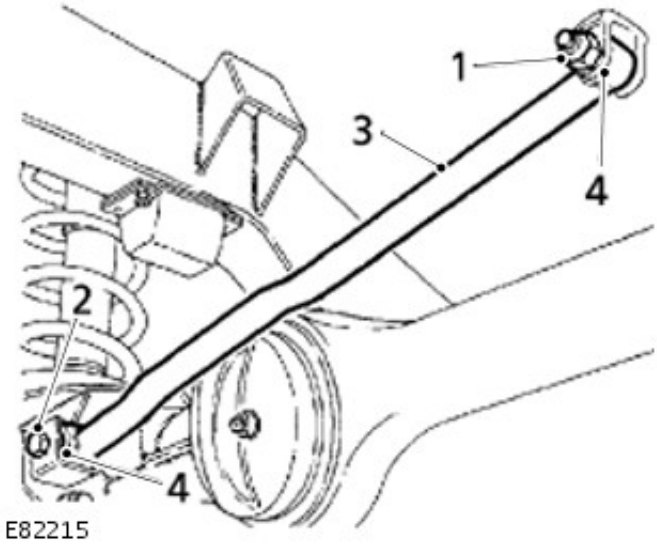
1. Fit link and castellated nut. Ensure ball joint link arm points up. Tighten nut to 40 Nm (30 lbf/ft) and fit new cotter pin.
2. Align stabilizer bar to links.
3. Fit bolts, washers and rubber bushes using new self locking nuts and secure stabilizer bar to links. Tighten fixings to 68 Nm (50 lbf/ft).
4. Lower vehicle.

Front Suspension - Panhard Rod

Removal and Installation

Removal

1. Remove fixings at mounting arm.
2. Remove fixings at axle bracket.
3. Remove panhard rod.
4. Using a suitable length of steel tubing, press out flexible bushes. Ensure tubing locates on outer edge of bush and not on rubber inner.



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Installation

1. CAUTION: Apply pressure to outer edge of bush, and not rubber inner.

   Install replacement bushes.

2. Install panhard rod to axle bracket and mounting arm. Tighten chassis fixing (**1**) to 200 Nm (148 lbf.ft). Tighten axle fixing (**2**) to 250 Nm (184 lbf.ft).

   - **Note**: If you are re-using fixings on a vehicle built prior to VIN 735937, then tighten the axle fitting to 250 Nm (184 lbf.ft) and the chassis fixing to 230 Nm (170 lbf.ft). If a new fixing is used on any vehicle, then use the torque settings of 200 Nm and 250 Nm, respectively.

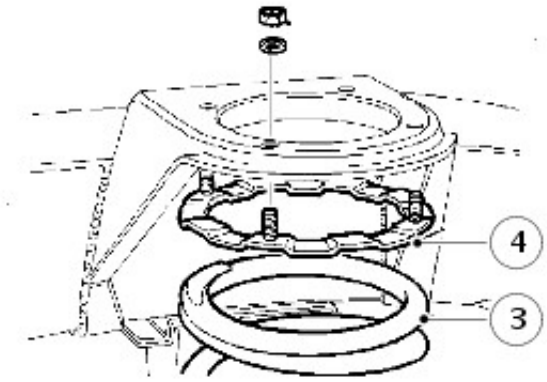
Front Suspension - Spring
Removal and Installation

Removal

1. Remove front shock absorber.
   For additional information, refer to: Front Shock Absorber (204-01 Front Suspension, Removal and Installation).

CAUTION: Avoid over stretching brake hoses. If necessary, loosen hose connector locknuts to allow hoses to follow axle.

2. Lower axle sufficient to free road spring.
3. Withdraw road spring.
4. Withdraw shock absorber bracket securing ring.



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Installation

1. Install shock absorber bracket retaining ring. Retain in position with a nut.
2. Position road spring and raise axle.
3. Remove nut retaining securing ring.
4. Install front shock absorber.
   For additional information, refer to: Front Shock Absorber (204-01 Front Suspension, Removal and Installation).

Front Suspension - Front Wheel Bearing and Wheel Hub

Removal and Installation

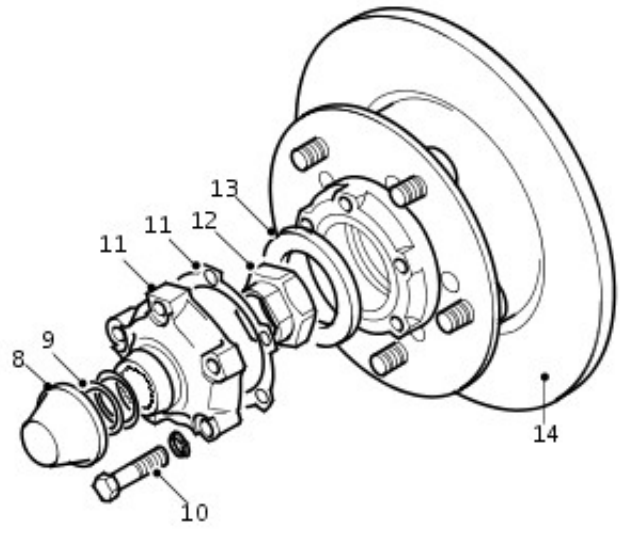
Removal

1. Raise front of vehicle.
2. WARNING: Support on safety stands.

   Remove front road wheel.
3. Pull back front brake caliper jump hose shield and clamp brake hose.
4. Position container collect brake fluid.
5. Loosen brake pipe to jump hose union and disconnect.

CAUTION: Use 2 spanners when loosening or tightening unions.

6. Remove 2 bolts securing brake caliper to hub.
7. Remove brake caliper.
8. Remove dust cap.
9. Remove circlip and shim(s) from drive shaft.
10. Remove and discard 5 bolts securing driving member to hub.
11. Remove driving member and discard gasket.
12. Knock back staking and using a suitable socket, remove and discard hub nut.
13. Remove washer from hub.
14. Remove hub and brake disc assembly complete with bearings.



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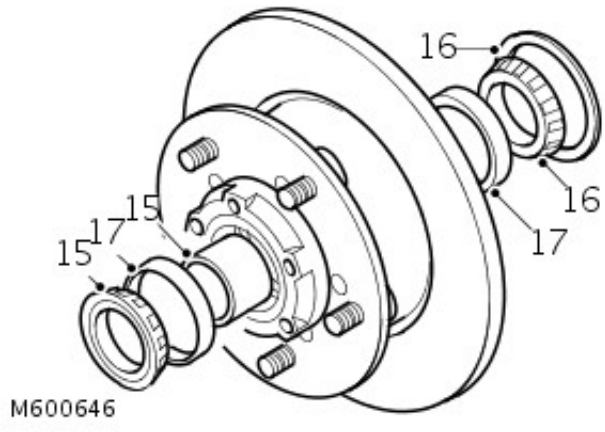
15. Remove outer bearing and spacer from hub.
16. Remove grease seal and inner bearing from hub.
17. Remove inner and outer bearing tracks from hub.



Installation

1. Clean hub and bearing locations.
2. Instal inner and outer bearing tracks to hub.
3. Pack inner bearing with grease and fit to hub.
4. Instal new seal flush with rear face of hub using LRT-54-003 and LRT-99-003.
5. Clean stub axle.
6. Pack outer bearing with grease, fit spacer and bearing to hub.
7. Position LRT-54-019 over hub nut threads on axle casing.
8. Instal hub assembly to stub axle, remove LRT-54-019.
9. Instal washer and new hub nut and tighten to 30 Nm (22 lbf.ft).
10. Rotate and push/pull hub to settle bearings. Tighten hub nut to 210 Nm (150 lbf.ft).
11. To check hub assembly end float, mount a dial gauge using bracket LRT-99-503 to driving member bolt hole.
12. Ensure dial gauge is contacting hub nut face.
13. Move hub assembly in and out noting dial gauge reading.
14. If end float is present refer to table for correct spacer and change spacer as necessary.

End float (mm)	Spacer size (mm)	Colour code
0.00	15.5	Purple
0.025	15.4	Yellow
0.050	15.4	Yellow
0.075	15.4	Yellow
0.10	15.3	Red
0.125	15.3	Red
0.150	15.3	Red
0.175	15.2	Blue
0.200	15.2	Blue
0.225	15.2	Blue
0.250	15.2	Blue
0.275	15.1	Green
0.300	15.1	Green
0.325	15.1	Green
0.350	15.1	Green
0.375	15.0	Black
0.400	15.0	Black
0.425	15.0	Black
0.450	15.0	Black
0.475	14.9	White
0.500	14.9	White
0.525	14.9	White
0.550	14.9	White

15. When no end float is evident, remove the dial gauge and

mounting bracket.

16. Stake the hub nut.

17. Clean hub and axle shaft faces.

18. Instal new driving member gasket.

19. Position driving member to hub and tighten new bolts to 65 Nm (48 lbf.ft).

20. Instal original shim(s) to drive shaft and secure with circlip.

21. Position brake caliper to hub, align fixings, instal bolts and tighten to 82 Nm (60 lbf.ft).

22. Remove plugs from brake pipe connections.

23. Connect brake pipe union to jump hose and tighten union.

CAUTION: Use 2 spanners when tightening or loosening unions.

24. Remove brake hose clamp from jump hose.

25. Bleed brake system.
For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

26. Instal road wheel, remove axle stand and tighten wheel nuts to 130 Nm (95 lbf.ft).

27. Operate foot brake to locate brake pads before taking vehicle on road.

Front Suspension - Wheel Studs

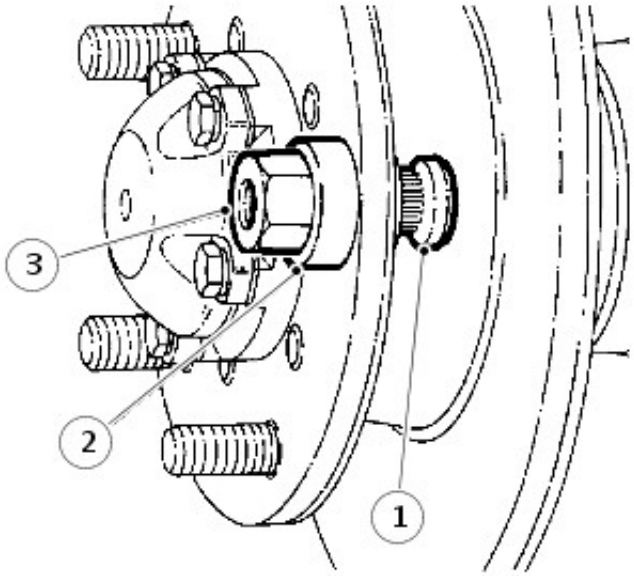
Removal and Installation

Removal

1. Remove wheel.
   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
2. Drive stud out of driveshaft flange.

Installation

1. Position stud in flange.
2. Install a suitable spacer over stud.
3. Using a M16 x 1.5 nut, a slave wheel nut is suitable, pull stud into flange until shoulder of stud abuts flange.



RR2141E

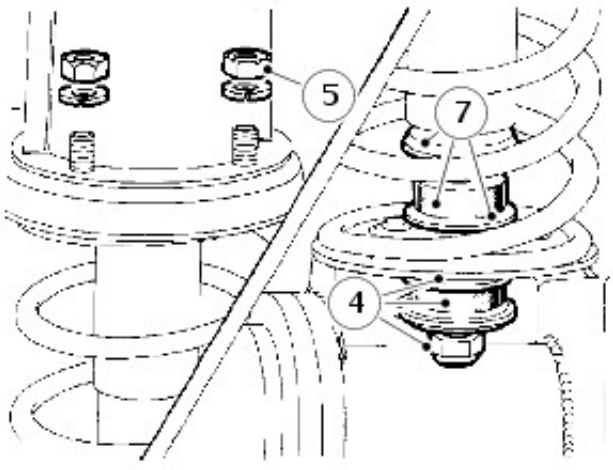
4. Refit wheel.
   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

Front Suspension - Front Shock Absorber

Removal and Installation

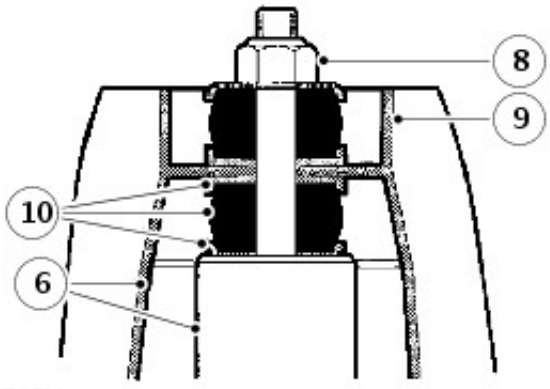
Removal

1. Loosen road wheel retaining nuts.
2. Support chassis on stands and remove road wheel.
3. Support axle weight with jack.
4. Remove shock absorber lower fixing and withdraw cupwasher, rubber bush and seating washer.
5. Remove four shock absorber bracket fixings.
6. Withdraw shock absorber and bracket assembly.
7. Withdraw lower seating washer, rubber bush and cupwasher.



RR2045E

8. Remove fixings, shock absorber to mounting bracket.
9. Withdraw mounting bracket.
10. Lift off top seating washer, rubber bush and cupwasher.



RR1595M

Installation

1. Assemble shock absorber components.
2. Position shock absorber, complete with bracket and secure with 4 fixings.

CAUTION: When tightening the nuts on both the upper and lower fixings, ensure that at least two threads are visible on the section of the bolt that extends beyond the nut.

3. Secure shock absorber lower fixing.
4. Install road wheel, remove chassis stands and jack. Tighten wheel nuts to correct torque:

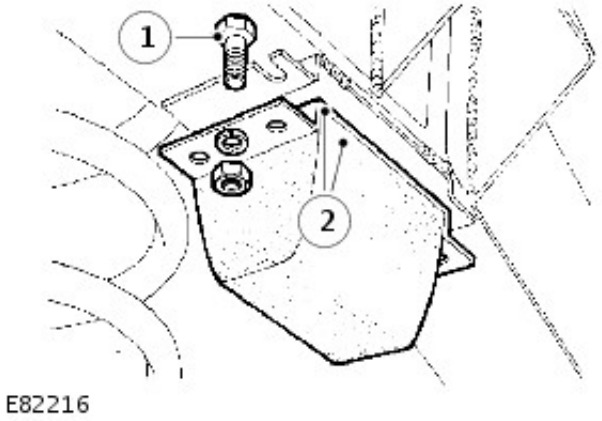
1. Alloy wheels - 130 Nm (96 lbf.ft)
2. Steel wheels - 100 Nm (80 lbf.ft)
3. Heavy duty wheels - 170 Nm (125 lbf.ft)

Front Suspension - Bump Stop

Removal and Installation

Removal

1. Remove the bump stop.



E82216

Installation

1. Position bolts in slots in chassis brackets.

2. Install the bump stop, secure with washers and nuts.

Front Suspension - Radius Arm

Removal and Installation

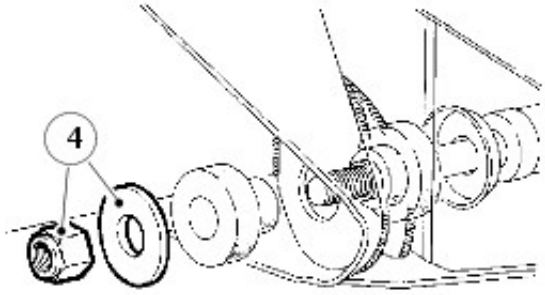
Removal

1. Loosen road wheel retaining nuts.

2. Raise front of vehicle. Support chassis on stands and remove wheel.

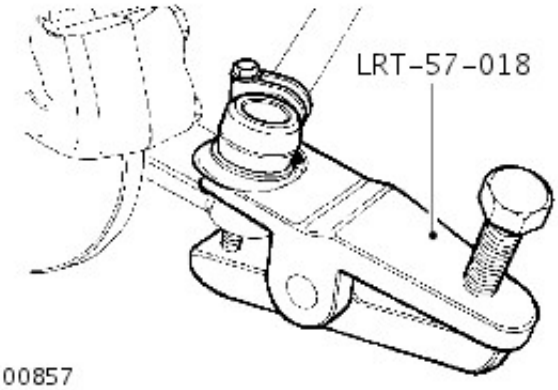
3. Support front axle weight with jack.

4. Remove radius arm to chassis side member fixings.



RR983

5. Disconnect track rod at ball joint using tool LRT-57-018.

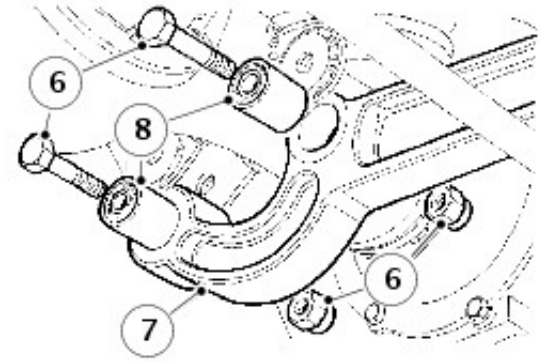


M600857

6. Remove fixings, radius arm to axle.

7. Lower radius arm front end to clear axle and remove from vehicle.

8. Using suitable length of steel tubing, press out flexible bushes.



RR1592

Installation

1. Press in replacement bushes.

CAUTION: When pressing in new bushes press on outer edge of bush and not rubber inner.

2. Install radius arm to axle mounting.

3. Instal track rod at ball joint.

4. Instal radius arm to chassis. Tighten bolts to 176 Nm (130 lbf.ft).

5. Fully tighten radius arm to axle fixings to 197 Nm (145 lbf.ft).

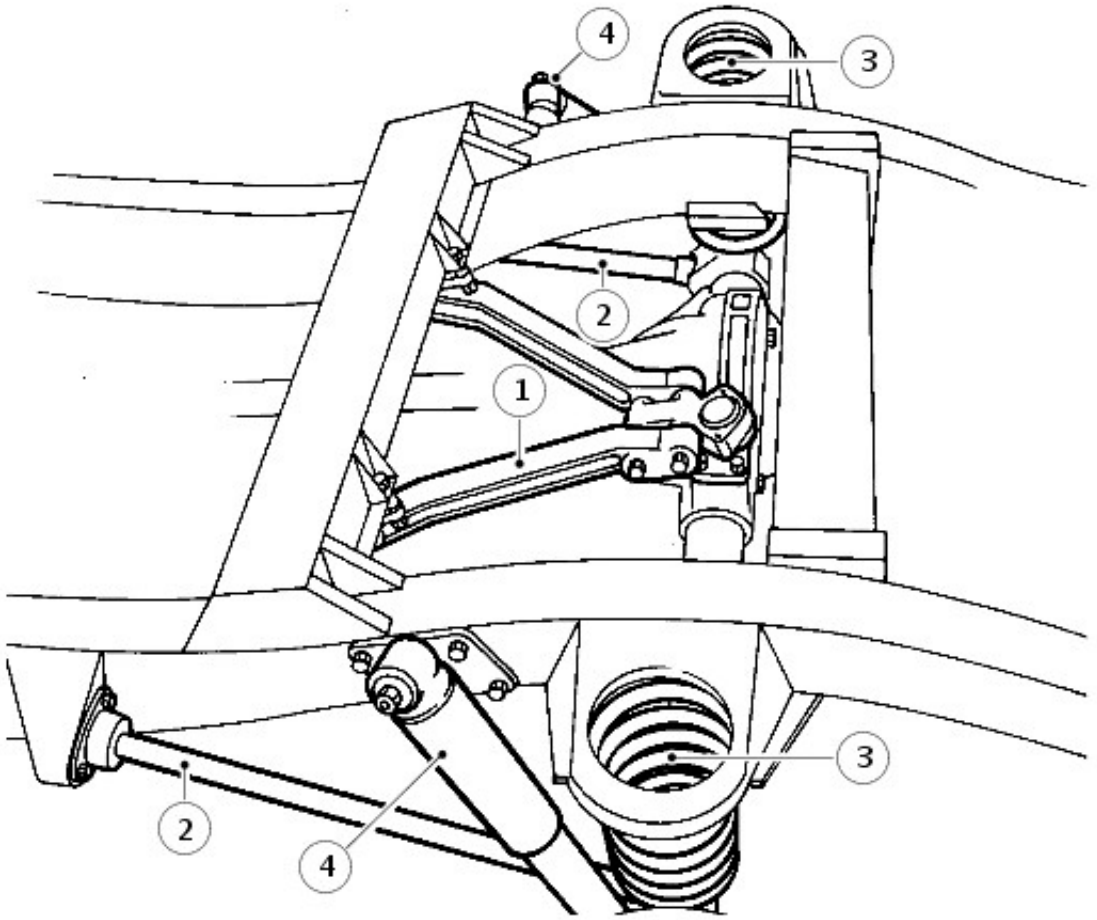
6. Instal road wheel, remove chassis stands and jack. Tighten wheel nuts to correct torque:

1. Alloy wheels - 130 Nm (96 lbf.ft)
2. Steel wheels - 100 Nm (80 lbf.ft)
3. Heavy duty wheels - 170 Nm (125 lbf.ft)

Rear Suspension - Rear Suspension

Description and Operation

Rear axle suspension



J5392M

Item	Part Number	Description
1	-	'A ' frame, upper link assembly
2	-	Lower link
3	-	Coil springs
4	-	Shock absorbers

DESCRIPTION

The rear suspension design locates the rear axle with two round section steel lower link arms and a forged 'A' frame, upper link assembly. This system allows maximum axle articulation and wheel travel while maintaining roll stiffness and directional stability.

The link arm is secured by a single retaining nut to the chassis mounting, comprising a rubber bushed bracket, which is retained by three fixings. A ferrule rubber bush with a single retaining bolt is used to secure the link arm to its axle mounting.

The upper link assembly is located on the rear differential housing by a pivot ball-pin assembly. Two brackets bolted to the chassis crossmember support both sides of the 'A' frame of the link assembly, secured by single retaining bolts.

A Boge Hydromat self levelling unit can be fitted, as an option, on 110/130 models to give additional support when the vehicle is used to carry heavier loads.

Two rubber bearing bushes, with retaining straps, secure the rear of the stabilizer bar, if fitted, to the chassis mountings, while bushed links support the front of the anti-roll bar to the axle.

Conventional long travel coil springs and hydraulic shock absorbers are used to control body movement. The shock absorbers are secured to chassis mounting brackets and fabricated lower mountings welded to the rear axle. Retaining plates are used to secure the coil springs to the axle mounting while fabricated brackets, welded to the chassis, are used for the upper spring location.

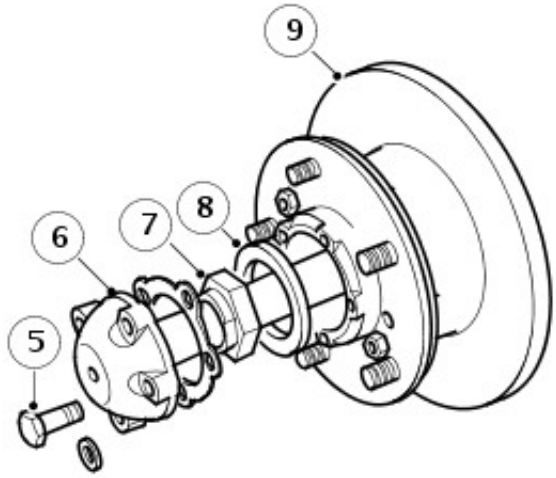
Rear Suspension - Wheel Bearing and Wheel Hub

Removal and Installation

Removal

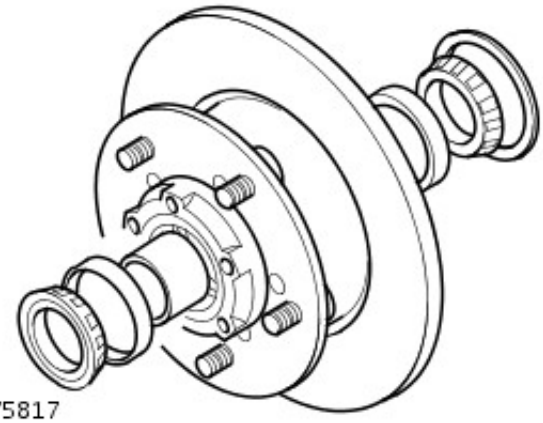
1. WARNING: Support on safety stands.

   Raise rear of vehicle.
2. Remove rear road wheel.
3. Remove 2 bolts securing brake caliper to hub.
4. Release caliper from disc and tie aside.
5. Remove 5 bolts securing axle shaft.
6. Remove axle shaft and discard gasket.
7. Knock back staking, and using a suitable socket, remove and discard stake nut.
8. Remove hub nut washer.
9. Remove hub and brake disc assembly complete with bearings.



M640067

10. Remove outer bearing and spacer from hub.
11. Remove grease seal and inner bearing from hub.
12. Remove inner and outer bearing tracks from hub.

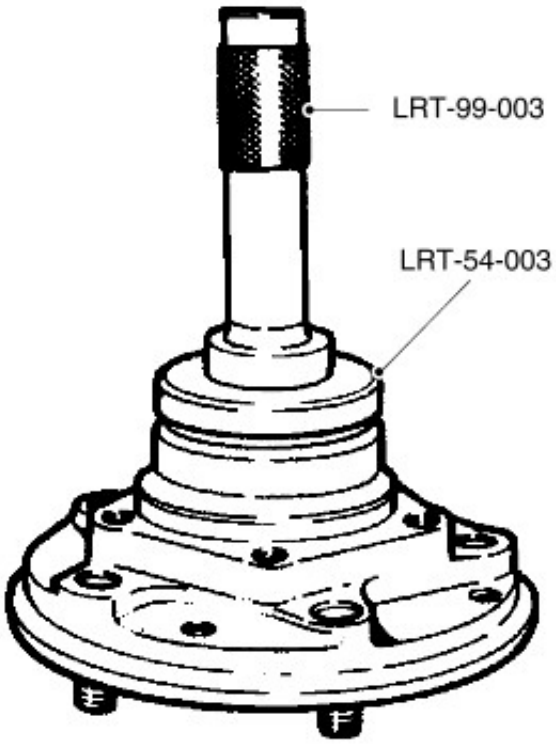


E75817

Installation

1. Clean hub and bearing locations.
2. Fit inner and outer bearing tracks to hub.
3. Pack inner bearing with grease and fit to hub.
4. Fit new grease seal flush with rear face of hub using LRT-

54-003 and LRT-99-003.



M510182

5. Clean stub axle.

6. Pack outer bearing with grease, fit spacer and bearing to hub.

7. Fit hub assembly to stub axle, remove LRT-54-019.

8. Fit washer and new hub nut and tighten to 30 Nm (22 lbf.ft).

9. Rotate and push/pull hub to settle bearings. Tighten hub nut to 210 Nm (150 lbf.ft).

10. To check hub end float, mount a dial gauge using bracket LRT-99-503 to driving member bolt hole.

11. Ensure dial gauge is contacting hub nut face.

12. Move hub in and out noting dial gauge reading.

13. If end float is present refer to table for correct spacer and change spacer as necessary.

End float (mm)	Spacer size (mm)	Colour code
0.00	15.5	Purple
0.025	15.4	Yellow
0.050	15.4	Yellow
0.075	15.4	Yellow
0.10	15.3	Red
0.125	15.3	Red
0.150	15.3	Red
0.175	15.2	Blue
0.200	15.2	Blue
0.225	15.2	Blue
0.250	15.2	Blue
0.275	15.1	Green
0.300	15.1	Green
0.325	15.1	Green
0.350	15.1	Green
0.375	15.0	Black
0.400	15.0	Black
0.425	15.0	Black
0.450	15.0	Black

0.475	14.9	White
0.500	14.9	White
0.525	14.9	White
0.550	14.9	White

14. When no end float is evident, remove the dial gauge and mounting bracket.

15. Stake the hub nut.

16. Clean hub and axle shaft faces.

17. Fit new driving member gasket.

18. Position driving member to hub and tighten new bolts to 65 Nm (48 lbf.ft).

19. Fit original shim(s) to drive shaft and secure with circlip.

20. Position caliper to hub, fit bolts and tighten to 82 Nm (61 lbf.ft).

21. Fit road wheel, remove axle stands and tighten road wheel nuts to 130 Nm (96 lbf.ft).

22. Operate brake pedal to locate brake pads before driving vehicle.

23. Check and top up brake fluid.

Rear Suspension - Spring

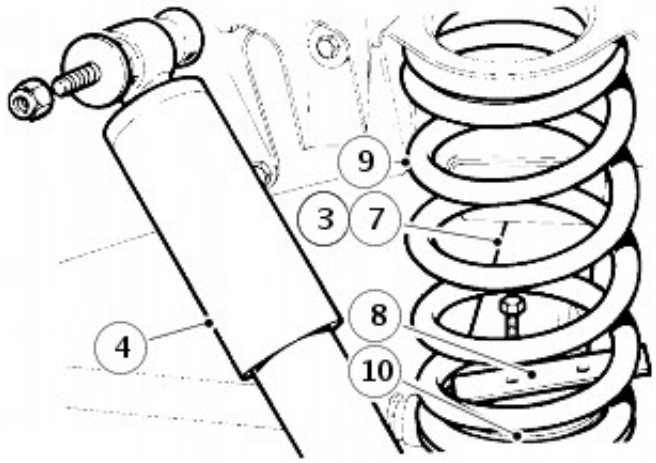
Removal and Installation

Removal

1. Loosen rear road wheel retaining nuts.
2. Support chassis on stands and remove wheels.
3. Support rear axle weight with jack.
4. Disconnect shock absorbers at one end.
5. Position coil spring compressor correctly on road spring.
6. Compress spring evenly to facilitate removal.
7. Lower axle to free road spring from upper seat.

CAUTION: Avoid lowering axle further than rear brake flexible hose will allow.

8. Remove spring retainer plate.
9. Withdraw road spring.
10. Collect spring seat.



RR3882M

Installation

1. Position spring seat on axle location.
2. Install road spring into chassis location and, using a turning motion, fit to spring seat.
3. Install spring retainer plate. Tighten bolts to 45 Nm (33 lbf.ft).
4. Secure shock absorber. Tighten upper fixing to 85 Nm (63 lbf.ft). Tighten lower fixing to 28 Nm (21 lbf.ft).
   - **Note**: For vehicles built prior to VIN 737011, discard the old fixings and tighten new fixing to the torque specified.
5. Install road wheels, remove chassis stands and jack. Tighten wheel nuts to correct torque:
   1. Alloy wheels - 130 Nm (96 lbf.ft)
   2. Steel wheels - 100 Nm (80 lbf.ft)
   3. Heavy duty wheels - 170 Nm (125 lbf.ft)

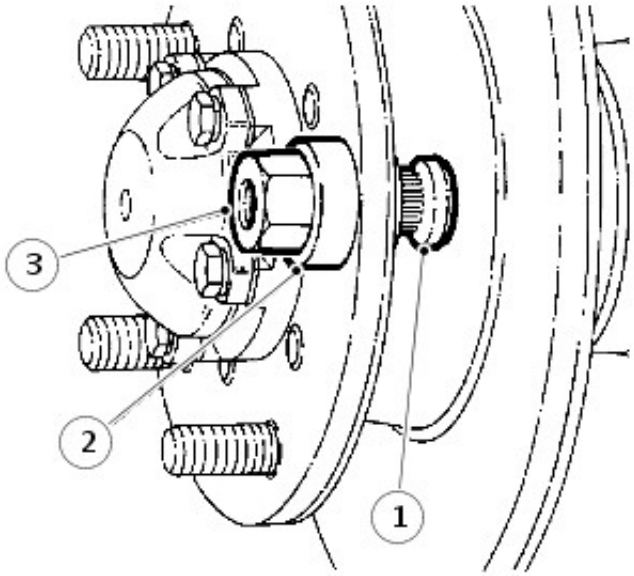
Rear Suspension - Wheel Studs
Removal and Installation

Removal

1. Remove wheel.
   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).
2. Drive stud out of driveshaft flange.

Installation

1. Position stud in flange.
2. Install a suitable spacer over stud.
3. Using a M16 x 1.5 nut, a slave wheel nut is suitable, pull stud into flange until shoulder of stud abuts flange.



RR2141E

4. Refit wheel.
   For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

Rear Suspension - Rear Stabilizer Bar

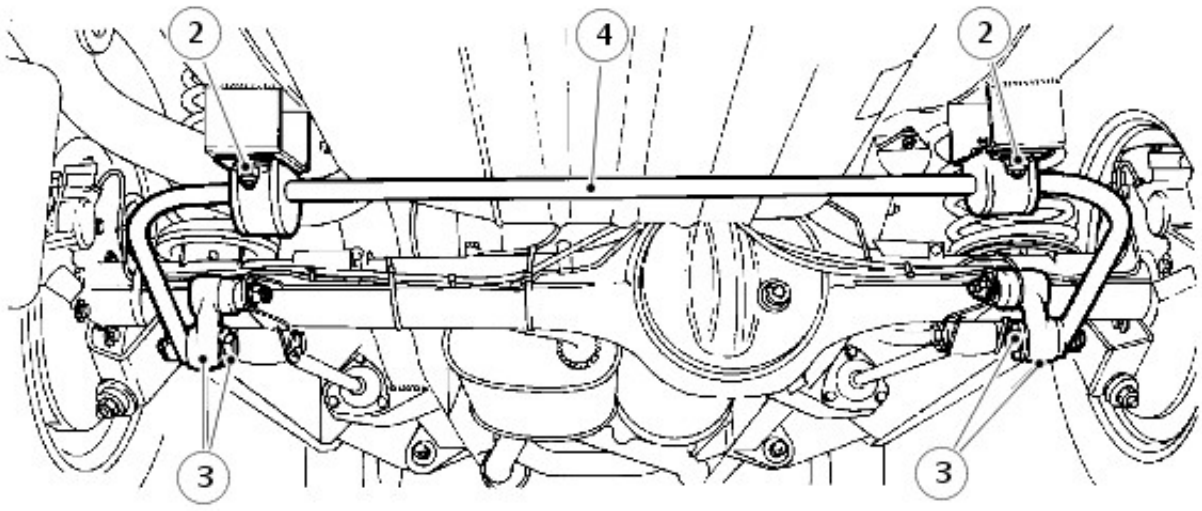
Removal and Installation

Removal

1. Note for reassembly, position of rubber bushes on stabilizer bar.
2. Remove 4 nuts, bolts and washers securing both stabilizer bar bush straps to chassis mounting brackets.
3. Remove nuts, bolts, washers and rubber bushes securing stabilizer bar to links.
4. Remove stabilizer bar.

Installation

1. Position rubber bushes on stabilizer bar. Instal joint towards axle.
2. Instal stabilizer bar with two straps. Ensure link arms point down as shown. Loosely instal, bolts, washers and new nyloc nuts.
3. Instal bolt, washers and rubber bushes. Instal anti-roll bar to links and tighten to 68Nm (50 lbf.ft).
4. Tighten nuts securing straps to 30Nm (22 lbf.ft).



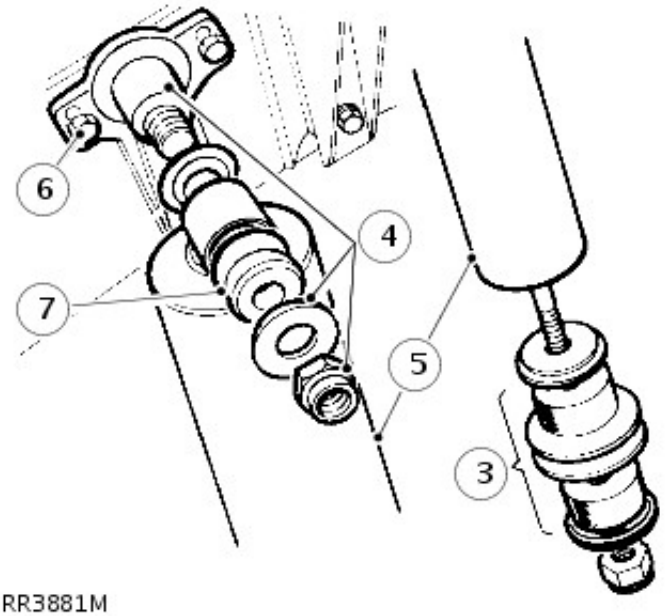
J6259

Rear Suspension - Rear Shock Absorber

Removal and Installation

Removal

1. Loosen road wheel retaining nuts.
2. Support chassis on stands. Remove road wheel and support rear axle weight with jack.
3. Remove fixings and withdraw shock absorber from axle bracket.
4. Remove upper fixings.
5. Withdraw shock absorber.
6. If required, remove mounting bracket
7. If required, remove mounting rubbers.



RR3881M

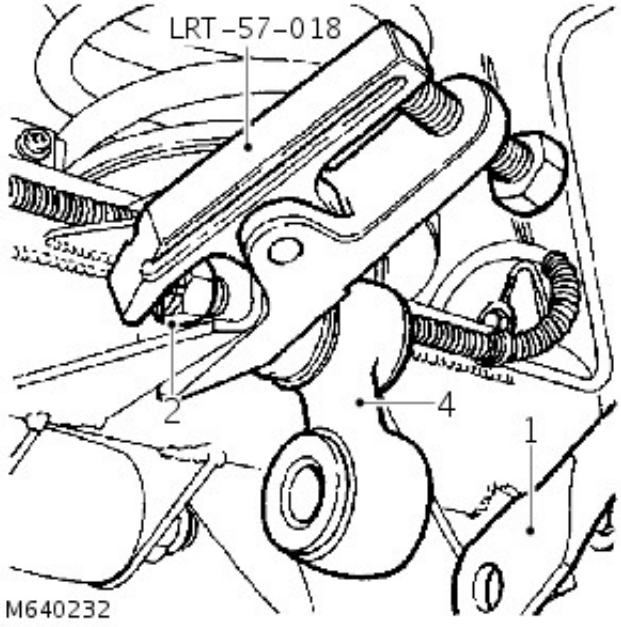
Installation

1. Position shock absorber and install upper fixings.
2. Secure shock absorber with lower fixings to axle bracket.
3. Tighten upper fixing to 85 Nm (63 lbf.ft). Tighten lower fixing to 28 Nm (21 lbf.ft).
   - **Note**: For vehicles built prior to VIN 737011, discard the old fixings and tighten new fixing to the torque specified.
4. Install road wheels, remove chassis stands and jack. Tighten wheel nuts to correct torque:
   1. Alloy wheels - 130 Nm (96 lbf.ft)
   2. Steel wheels - 100 Nm (80 lbf.ft)
   3. Heavy duty wheels - 170 Nm (125 lbf.ft)

Rear Suspension - Rear Stabilizer Bar Link

Removal and Installation

Removal



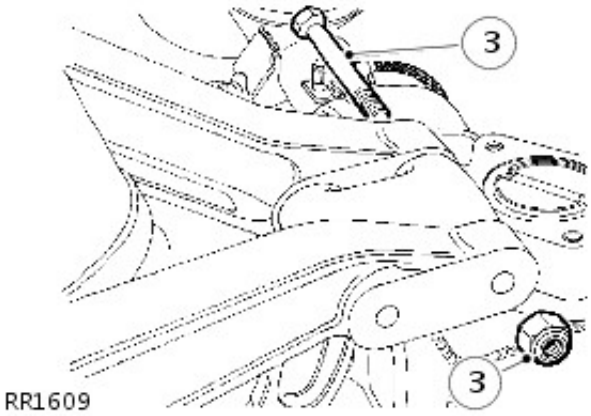
1. Remove 2 nuts, bolts, washers and rubber bushes from links and lower stabilizer bar to clear links.
2. Remove cotter pin and loosen castellated nut a few turns.
3. Release link using tool LRT-57-018 as shown.
4. Remove castellated nut and remove link.

Installation

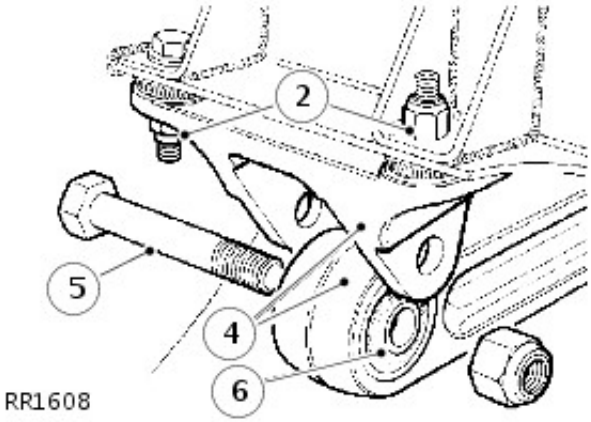
1. Install stabilizer bar link arm and castellated nut. Point link arm down as shown. Tighten fixing to 40 Nm (30 lbf.ft) and fit new cotter pin.
2. Align stabilizer bar to links.
3. Install bolts, washers and rubber bushes using new self locking nuts and secure stabilizer bar to links. Tighten to 6 8Nm (50 lbf.ft).

Rear Suspension - Upper Arm
Removal and Installation

Removal



1. Support rear of chassis on stands, allow axle to hang freely.
2. Remove fixings securing upper arm bracket to frame.
3. Remove fixings securing upper arms to pivot bracket.
4. Remove upper arm, complete with frame bracket.
5. Remove bolt.
6. Separate upper arm from bracket.



7. Renew bush
8. Press out rubber bushes.
9. CAUTION: Apply pressure to outer edge of bush, and not rubber inner.

   Fit bush centrally in housing.

Installation

1. NOTE: Do not fully tighten fixings until all components are in position.

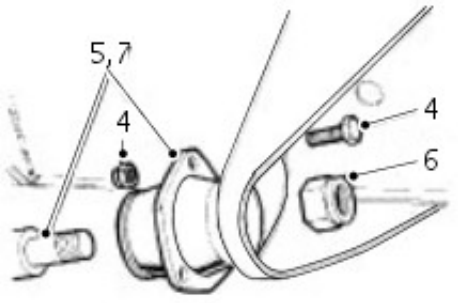
   Secure upper arm to frame bracket.
2. Fit upper arm to pivot bracket and tighten fixings to 115 Nm (84 lbf/ft).
3. Fit frame bracket to chassis mounting.
4. If you are fitting a new nut to the upper arm bolt, fully tighten to 115 Nm (84 lbf/ft). If you are refitting an existing nut, then tighten to 176 Nm (130 lbf/ft).

Rear Suspension - Lower Arm

Removal and Installation

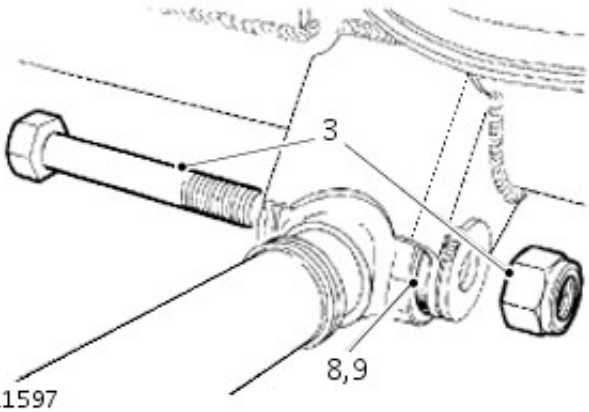
Removal

1. Site vehicle on a ramp .
2. Alternatively, support vehicle on stands under rear axle.
3. Remove lower arm rear fixings.
4. Remove mounting bracket fixings at side member bracket.
5. Remove lower arm complete.
6. Remove locknut.
7. Remove mounting bracket from lower arm.



RR1598

8. Renew bush
9. Press out rubber bushes.



RR1597

Installation

1. CAUTION: Apply pressure to outer edge of bush, and not rubber inner.

   Fit bush centrally in housing.
2. Fit mounting rubber to lower arm.
3. Secure mounting rubber to chassis bracket, but do not fully tighten locknut.
4. Fit lower arm to axle mounting and secure fixing to 176 Nm (130 lbf/ft).
5. Lower vehicle, allow axle to take up static laden position, and fully tighten lower arm to chassis fixing to 176 Nm (130 lbf/ft).

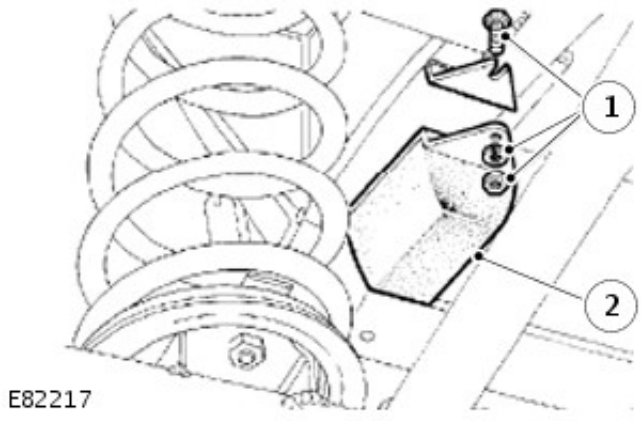
Rear Suspension - Axle Bump Stop

Removal and Installation

Removal

1. Remove fixings.

2. Remove bump stop.



Installation

1. Position bolts in slots in bracket.

2. Install bump stop, secure with washers and nuts.

Wheels and Tires -

Wheels - 90 Models

WARNING: Always use the same make and type of radial-ply tyres, front and rear. DO NOT use cross-ply tyres, or interchange tyres from front to rear.

Wheel type	Wheel size
Steel wheel - UK and Western Europe	6F x 16
Steel wheel - Other markets	5.5F x 16
Alloy wheel	7J x 16

Wheels

WARNING: Always use the same make and type of radial-ply tyres, front and rear. DO NOT use cross-ply tyres, or interchange tyres from front to rear.

If the wheel is marked 'TUBED' , an inner tube MUST be fitted, even with a tubeless tire. If the wheel is marked 'TUBELESS', an inner tube must NOT be fitted.

Wheel type	Wheel size
Steel wheel - UK and Western Europe	6F x 16
Steel wheel - Other markets except Japan	5.5F x 16
Steel wheel - Japan	6.5J x 16
Alloy wheel	7J x 16

Tire sizes

Model	Tire size
90	205/80 R16 Radial
	265/75 R16 Radial (Multi terrain)
	7.50 R16 Radial
110 - except Japan	7.50 R16 Radial
110 Japan	7.50 R16C
130	7.50 R16 radial

Tire pressures

Model - Tire size	Front	Rear
90 - 205/80 R16	1,9 bar	2,6 bar
	28 lbf/in²	38 lbf/in²
	2,0 kgf/cm²	2,7 kgf/cm²
90 - 265/75 R16	1,9 bar	2,4 bar
	28 lbf/in²	35 lbf/in²
	2,0 kgf/cm²	2,7 kgf/cm²
90 - 7.50 R16	1,9 bar	2,6 bar
	28 lbf/in²	38 lbf/in²
	2,0 kgf/cm²	2,7 kgf/cm²
110 - 7.50 R16 (except Japan)	1,9 bar	3,3 bar
	28 lbf/in²	48 lbf/in²
	2,0 kgf/cm²	3,4 kgf/cm²
110 - 7.50 R16C (Japan)	2,2 bar	4,1 bar
	32 lbf/in²	60 lbf/in²
	2,3 kgf/cm²	4,3 kgf/cm²
130 - 7.50 R16	3,0 bar	4,5 bar
	44 lbf/in²	65 lbf/in²
	3,1 kgf/cm²	4,6 kgf/cm²

Road Wheel Nut Torque Specifications

Wheel type	Nm	lb-ft
*Steel wheels	100	80
Alloy wheels	130	96
Heavy duty wheels	170	125

*** Wheel nuts must be tightened by diagonal selection**

Wheels and Tires - Wheels and Tires

Description and Operation

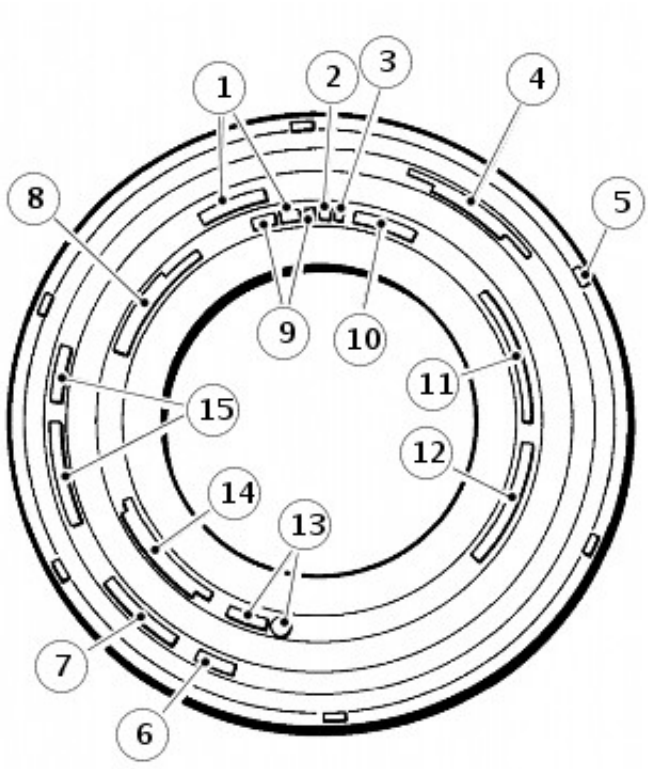
GENERAL

Dependent on specification and model type, the vehicle is equipped with pressed steel or alloy wheel rims, both using tubeless radial ply tires.

Tire codes

The text, codes and numbers moulded into the tire wall vary between tire manufacturers, however most tires are marked with the information shown in the illustrated example.

• NOTE: The illustration is an example of the type of markings moulded into tires and is for guidance only. For specific tire specifications.
For additional information, refer to: Specifications (204-04 Wheels and Tires, Specifications).



RR3854M

Item	Part Number	Description
1.	-	Type of tire construction - **Radial Ply**
2.	-	Load index - **104**
3.	-	Speed symbol - **S or T**
4.	-	USA Tyre quality grading - **Tread wear 160 Traction A temperature B**
5.	-	Tread wear indicators moulded into tread pattern are located at intervals around the tire and marked by a code - **E66 103S6**
6.	-	Tyres with 'Mud Snow' type tread pattern are marked - **M and S**
7.	-	Tyre reinforcing mark - **Reinforced**
8.	-	USA Load and pressure specification - **(900Kg(1984LBS) at 340KA (50PSI) MACS PRESS**
9.	-	Tyre size - **205 16 or 235/70 R16**
10.	-	Type of tire - **TUBELESS**
11.	-	Country of manufacture - **MADE IN GREAT BRITAIN**
12.	-	USA Compliance symbol and identification - **DOT AB7C DOFF 267**
13.	-	European type approval identification - **E11 01234**
14.	-	Tire construction - **SIDE WALL 2 PLIES RAYON. TREAD 2 RAYON 2 STEEL**
15.	-	Manufacturers brand name/type - **TRACTION PLUS mzx M**

WARNING: This is a multi-purpose vehicle with wheels and tires designed for both on and off road usage. Only use wheels and tires specified for use on the vehicle.

The vehicle is equipped with tubeless 'S','T' or 'H' rated radial ply tires as standard equipment. The tires are of European metric size and must not be confused with the "P" size metric tires available in North America.

Vehicle wheel sets, including spare wheel, must be fitted with the same make and type of tire to the correct specification and tread pattern. Under no circumstances must cross-ply or bias-belted tires be used.

WARNING: DO NOT fit an inner tube to an alloy wheel.

For tire specification and pressures.
For additional information, refer to: Specifications (204-04 Wheels and Tires, Specifications).

Steel wheels

Tubeless tires are mounted on 5.5 or 6.5 inch wide by 16 inch diameter steel wheels.

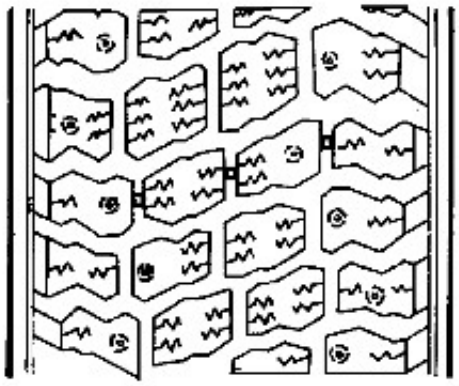
Alloy Wheels

Tubeless tires are mounted on 7.0 inch wide by 16 inch diameter cast aluminium alloy wheels. The surface has a paint finish covered with a clear polyurethane lacquer. Care must be taken when handling the wheel to avoid scratching or chipping the finish. The alloy wheel rim is of the asymmetric hump type incorporating a safety hump to improve location of the tire bead in its seat. If difficulty is experienced in fitting tires to this type of rim. See
For additional information, refer to: Wheel and Tire (204-04 Wheels and Tires, Removal and Installation).

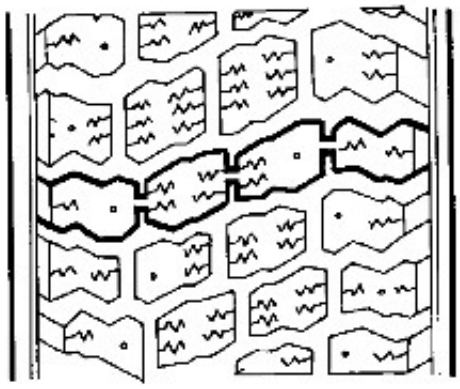
TIRE INSPECTION

Inspect tires at weekly intervals to obtain maximum tire life and performance and to ensure compliance with legal requirements. Check for signs of incorrect inflation and uneven wear, which may indicate a need for balancing or front wheel alignment, if the tires have abnormal or uneven wear patterns. See Tire Wear Chart in this section.

Check tires at least weekly for cuts, abrasions, bulges and for objects embedded in the tread. More frequent inspections are recommended when the vehicle is regularly used in off road conditions.


RR2145E

To assist tire inspection, tread wear indicators are moulded into the bottom of the tread grooves, as shown in the illustration above.


RR2146E

When the tread has worn to a depth of 1.6 mm the indicators appear at the surface as bars which connect the tread pattern across the width of the tread as shown in the illustration above.

• NOTE: DO NOT attempt to interchange tires, e.g. from front to rear, as tire wear produces characteristic patterns depending on their position. If tire position is changed after wear has occurred, the performance of the tire will be adversely affected.

• NOTE: Territorial vehicle regulations governing tire wear MUST be adhered to.

When the indicators appear in two or more adjacent grooves, at three locations around the tire, a new tire must be fitted.

Wheel inspection

Regularly check the condition of the wheels. Replace any wheel that is bent, cracked, dented or has excessive runout.

Valve inspection

Check condition of inflation valve. Replace any valve that is worn, cracked, loose, or leaking air.

Tire pressures

Maximum tire life and performance will be obtained only if tires are maintained at the correct pressures .

Tyre pressures must be checked at least once a week and preferably daily, if the vehicle is used off road.

The tire inflation pressure is calculated to give the vehicle satisfactory ride and steering characteristics without compromising tire tread life. For recommended tire pressures in all conditions.
For additional information, refer to: Specifications (204-04 Wheels and Tires, Specifications).

Always check tire inflation pressures using an accurate gauge and inflate tires to the recommended pressures only .

Check and adjust tire pressures ONLY when the tires are cold, vehicle parked for three hours or more, or driven for less than 3.2 km (2 miles) at speeds below 64 km/h (40 mph). Do not reduce inflation pressures if the tires are hot or the vehicle has been driven for more than 3.2 km (2 miles) at speeds over 64 km/h (40 mph), as pressures can increase by 0.41 bars (6 lb/in²) over cold inflation pressures.

Check ALL tire pressures including the spare. Refit the valve caps as they form a positive seal and keep dust out of the valve.

WHEEL BALANCING

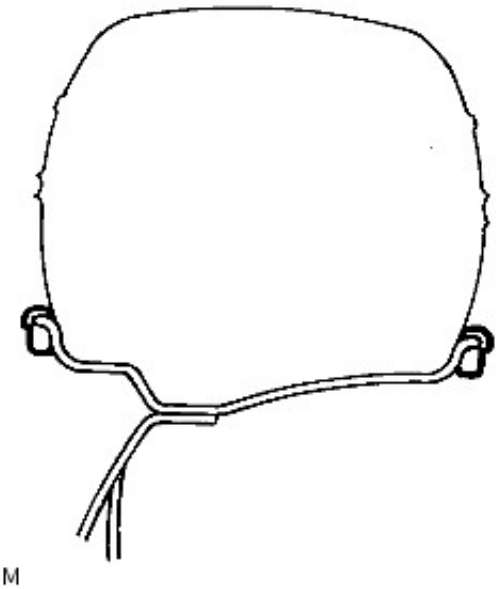
CAUTION: It is essential that all wheel balancing is carried out off the vehicle. The use of on the vehicle balancing could cause component damage or personal injury and MUST NOT be attempted.

• NOTE: Before attempting to balance a wheel and tire assembly clean all mud and dirt deposits from both inside and outside rims and remove existing balance weights.

Remove stones from the tire tread in order to avoid operator injury during dynamic balancing and to obtain the correct balance.

Inspect tires for damage and correct tire pressures and balance according to the equipment manufacturer's instructions.

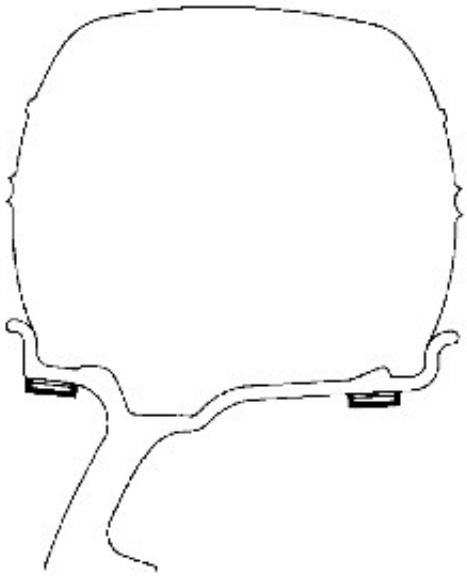
Steel wheels



RR2211M

Clean area of wheel rim and attach balance weights in position shown.

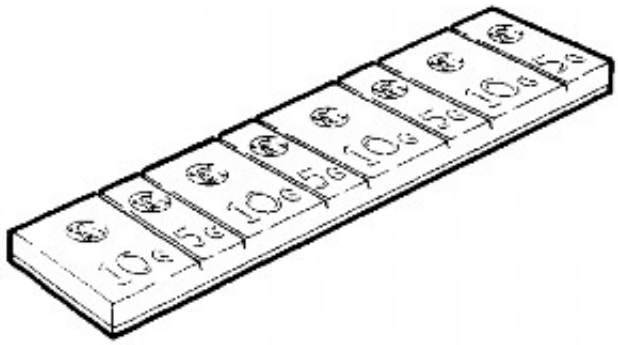
Alloy wheels



RR2138E

Clean area of wheel rim and attach adhesive balance weights in position shown. Cut through rear face of weight strip to detach required weights.

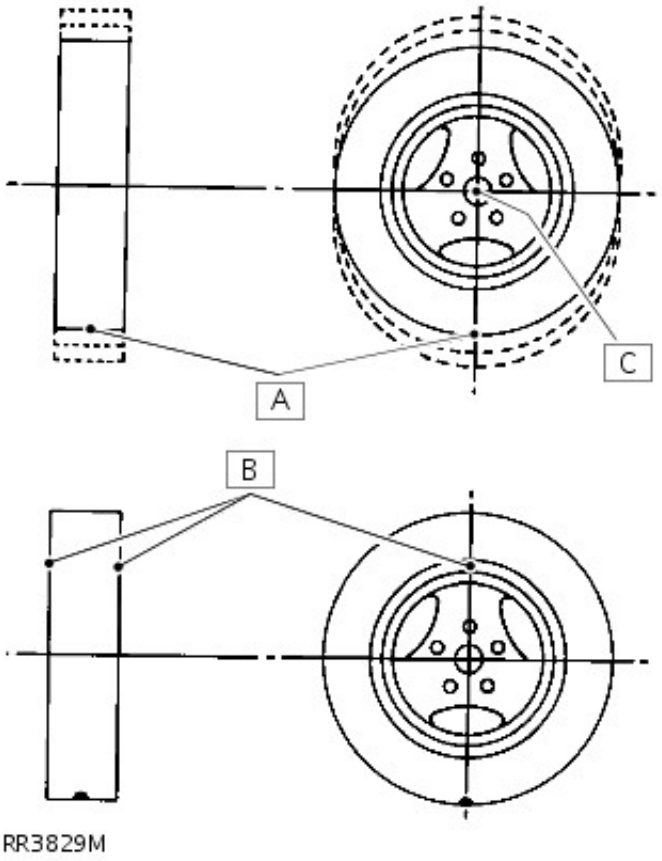
CAUTION: Use only correct adhesive balance weights to avoid damage to aluminium wheel rim. DO NOT attempt to use a steel wheel weight on an aluminium wheel.



RR2137E

Static Balance

Wheel tramp



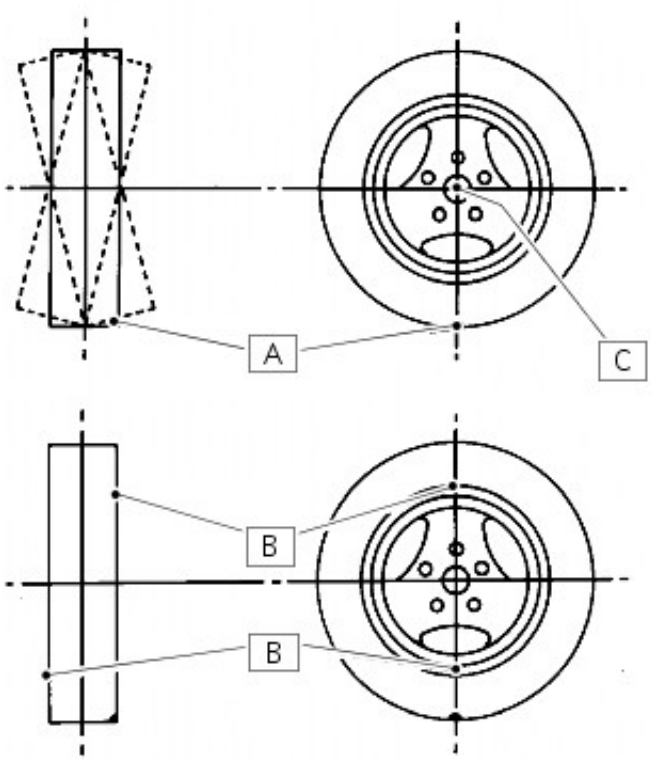
RR3829M

Item	Part Number	Description
A	-	Heavy spot.
B	-	Add balance weights here.
C	-	Centre line of spindle.

Static balance is the equal distribution of weight around the wheel. A statically unbalanced wheel will cause a bouncing action called wheel tramp. This condition will eventually cause uneven tire wear.

Dynamic Balance

Wheel shimmy



RR3830M

Item	Part Number	Description
A	-	Heavy spot.
B	-	Add balance weights here.
C	-	Centre line of spindle.

Dynamic balance is the equal distribution of weight on each side of the centre line so that when the wheel spins there is no tendency for side to side movement. A dynamically unbalanced wheel will cause wheel shimmy.

Off Vehicle Balancing

Balance wheel assembly referring to equipment manufacturer's instructions.

It is essential that the wheel is located by the centre hole NOT the stud holes. To ensure positive wheel location the diameter of the locating collar on the machine shaft must be 112,80 to 112,85 mm (4.441 to 4.443 in). This diameter will ensure that the collar fits correctly within the centre hole of the wheel.

Where possible, always use the vehicle wheel retaining nuts to locate the wheel on the balancer, to avoid damaging the wheel. If this is not possible, the locating nuts must be of a similar pattern to the original wheel nuts. The use of conical type wheel nuts for this purpose may damage the surface on alloy wheels.

Cleaning

Wash the aluminium wheels using a suitable wash and wax concentrate, correctly diluted and rinse with cold clear water. DO NOT use abrasives or aluminium wheel cleaners containing acid, as they will destroy the lacquer finish.

Tire changing

Use only tire changing equipment to mount or demount tires, following the equipment manufacturer's instructions. DO NOT use hand tools or tire levers, as they may damage tire beads or the wheel rim.

Puncture repair

Remove punctured tire from wheel and repair using a combination service plug and vulcanising patch. Always follow manufacturer's instructions when using a puncture repair kit.

Only punctures in tread area are reparable, DO NOT attempt to repair punctures in tire shoulders or sidewalls.

Do not attempt to repair a tire that has sustained the following: bulges or blisters, ply separation, broken or cracked beads, wear indicators visible and punctures larger than 6 mm diameter.

CAUTION: Do not use tire sealants that are injected through valve stem to repair punctured tires, they may

produce wheel corrosion and tire imbalance.

Aluminium wheel rim bead seats should be cleaned using a non-abrasive cleaner to remove the mounting lubricants and old rubber. Before mounting or demounting a tire, bead area should be well lubricated with a suitable tire lubricant.

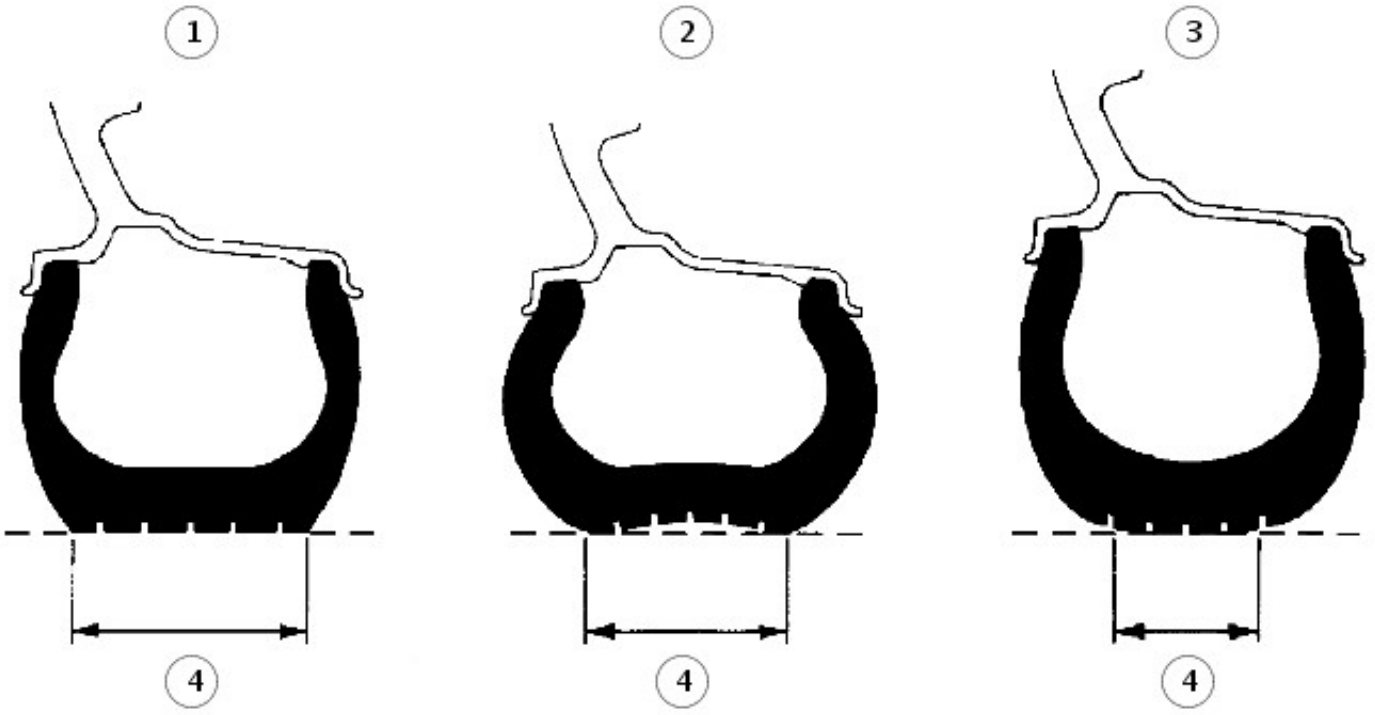
FAULT- SYMPTOMS

- Check tyre pressures.
  For additional information, refer to: Specifications (204-04 Wheels and Tires, Specifications).
- Check condition of tyres.
- Check front wheel alignment.
  For additional information, refer to: Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
- Check wheel balance.

• NOTE: In the event that any apparent vibration is not eliminated at this stage.

• NOTE: In the event that any apparent vibration is not eliminated at this stage, go to steering Fault Diagnosis, Fault - Symptom (Steering vibration, road wheel shimmy/wobble).
For additional information, refer to: Steering System (211-00 Steering System - General Information, Diagnosis and Testing).

• NOTE: Radial ply tyres have a flexible sidewall, which produces a sidewall bulge making the tyre appear under-inflated. This is a normal condition for radial ply tyres. Do not attempt to reduce this bulge by over-inflating the tyre.



RR2133E

Item	Part Number	Description
1.	-	Correct inflation.
2.	-	Under-inflation.
3.	-	Over-inflation.
4.	-	Tread contact with road.

Tire wear chart

CAUTION: This chart is for general guidance only and does not necessarily include every cause of abnormal tire wear.

Fault	Cause	Remedy
Rapid wear at shoulders	Tires under inflated	Inflate to correct pressure
	Worn suspension components; i.e. ball joints, Panhard rod bushes, steering damper	Replace worn components

Rapid wear at centre of tread	Tires over inflated	Inflate to correct pressure
Wear at one shoulder	Track out of adjustment	Adjust track to correct figure
	Bent Panhard rod	Check and replace worn or damaged components
Bald spots or tire cupping	Wheel out of balance	Balance wheel and tire assembly
	Excessive radial run out	Check run out and replace tire if necessary
	Shock absorber worn	Replace shock absorber
	Excessive braking	
Tire scalloped	Track out of adjustment	Adjust track to correct figure
	Worn suspension components	Check and replace worn or damaged components, and replace tire
	Excessive cornering speeds	

Wheels and Tires - Wheel and Tire

Removal and Installation

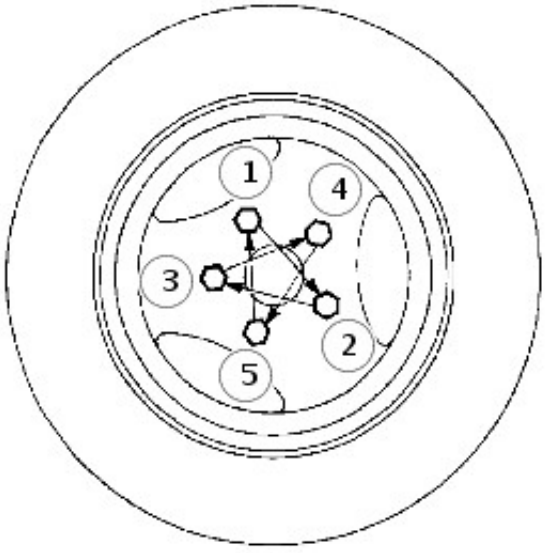
Removal

WARNING: The parking brake acts on transmission, not rear wheels, and may not hold vehicle when jacking unless following procedure is used. If one front wheel and one rear wheel is raised no vehicle holding or braking effect is possible. Wheels MUST be chocked in all circumstances.

1. Apply parking brake, select a gear in main gearbox and engage low gear in transfer box.
2. Loosen 5 wheel nuts.
3. Using a suitable trolley jack, raise vehicle and place on axle stands.
   For additional information, refer to: Jacking (100-02 Jacking and Lifting, Description and Operation).
4. Remove wheel nuts and carefully withdraw wheel over studs.

Installation

1. Ensure that retaining studs and nuts are clean.
2. **Alloy wheels:** Lightly coat wheel mounting spigot face with a suitable anti-seize compound to minimise possibility of adhesion between wheel and spigot face.
3. Refit wheel taking care not to damage stud threads. (Do not apply oil).
4. Fit wheel nuts and turn by hand for at least three full threads before using any form of wheel wrench.
5. Tighten nuts as much as possible using a suitable wrench.



RR2142E

6. Lower vehicle and finally tighten nuts to correct torque sequence shown.

   1. Alloy wheels - 130 Nm
   2. Steel wheels - 100 Nm
   3. Heavy duty wheels - 170 Nm

Vehicle Dynamic Suspension - Rear Air Shock Absorber

Removal and Installation

Removal

WARNING: The self-levelling unit contains pressurised gas and MUST NOT be dismantled. Repair is by replacement of complete unit only.

• NOTE: This procedure covers the suspension self-levelling unit.

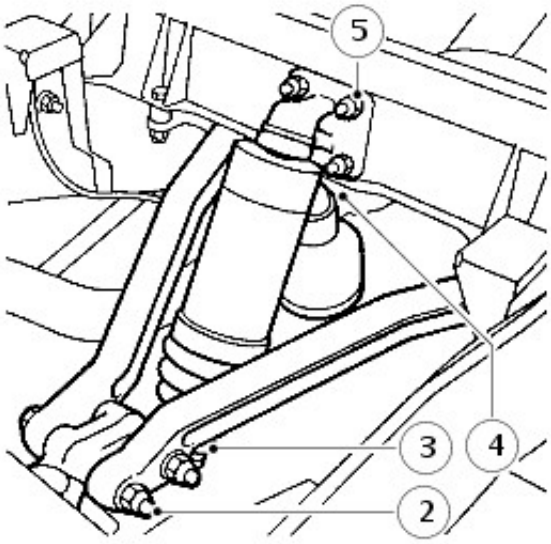
1. Raise and support the vehicle under chassis and use a jack to support weight of the axle.

2. Disconnect upper links at pivot bracket.

3. Ease up self-levelling unit lower gaiter and unscrew lower ball joint at push rod using thin jawed spanners.

4. Release webbing strap from the chassis.

5. Remove 4 nuts securing top bracket to chassis and withdraw self-levelling unit complete with bracket.



J6269

6. Renew self-levelling unit ball joints

7. Unscrew lower ball joint from pivot bracket.

8. Unscrew ball joint from top bracket.

9. Reassemble ball joints, packing with Dextagrease G.P. or equivalent. Renew joints if worn.

10. Check condition of gaiters and renew if necessary.

Installation

1. Ensure ball pin threads are clean and smear Loctite grade CVX on ball pin threads.

2. Fit upper ball joint to self-levelling unit and secure gaiter.

3. Fit top bracket complete with levelling unit to chassis and secure with 4 nuts and tighten to 47 Nm (35 lbf/ft).

4. Fit self-levelling unit to lower ball joint and secure gaiter.

5. Attach webbing strap to chassis cross member.

6. Fit upper links to the pivot bracket and retain with 2 bolts and nuts but do not tighten at this stage.

7. Remove jack in support of axle and support from under chassis.

8. Allow suspension to settle and then tighten 2 bolts and nuts retaining upper links to pivot bracket to 176 Nm (130 lbf/ft).

Driveshaft - Driveshaft

Description and Operation

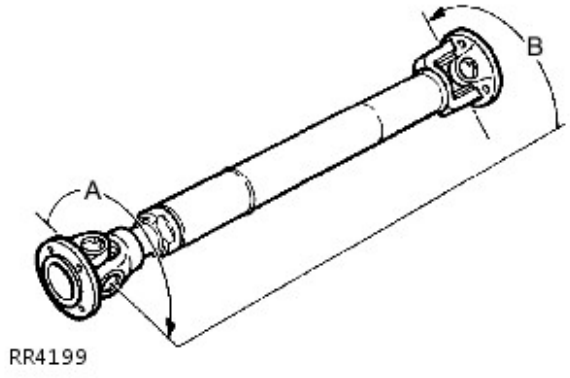
Description

The front and rear drive shafts have non-constant velocity type universal joints, with needle roller bearings. The bearing cups are pre-packed with lubricant on assembly and a grease nipple is fitted for servicing as specified, in maintenance section.

Both shafts have ball splines to accommodate the variation in distance between the axles and transmission. The splines are pre-packed with lubricant and protected by a rubber gaiter.

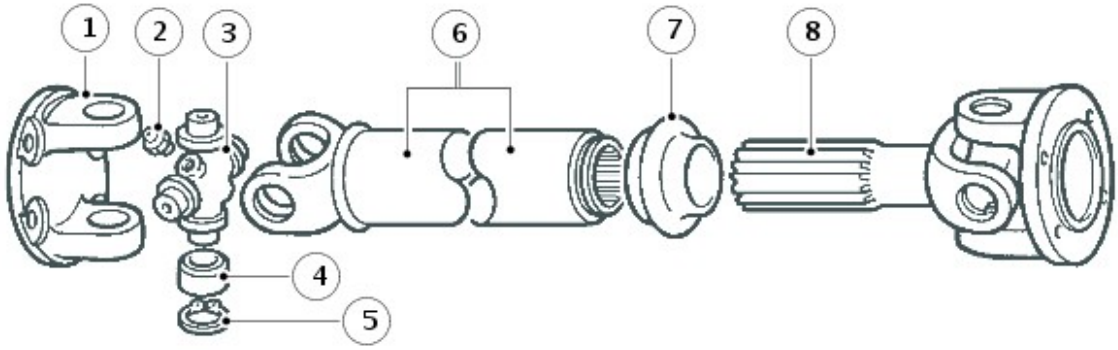
• NOTE: This joint does not require lubrication.

The front and rear driveshafts are 'phased', with the joints at each end, A and B mis-aligned as shown.



RR4199

The phasing is necessary to allow for greater variation in angular changes. On reassembly it is essenital the driveshafts are realigned correctly.



J6284

Item	Part Number	Description
1.	-	Flanged yoke
2.	-	Grease nipple
3.	-	Journal spider
4.	-	Needle roller bearing
5.	-	Circlip
6.	-	Splined shaft
7.	-	Rubber gaiter (dust cap)
8.	-	Ball spline shaft

Vibration Harshness

Check the propeller shaft universal joints are not seized or worn by checking for excessive radial and axial movement. This can be done by inserting a suitable lever into the joint and checking for movement. In the event that both shafts are satisfactory, but the vibration/harshness is still present, the transfer box operation and balance of the road wheels should be checked.

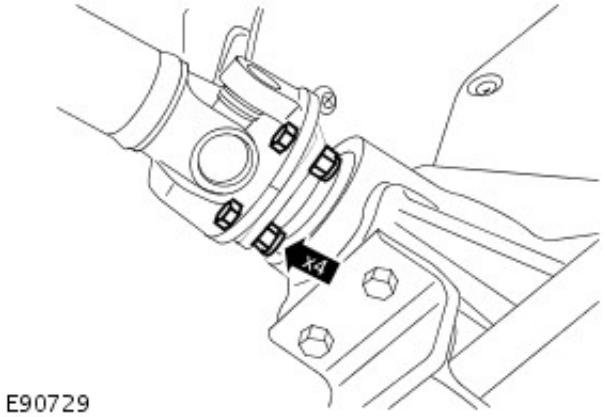
Driveshaft - Front Driveshaft
Removal and Installation

Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. NOTE: Mark the front driveshaft to front differential drive flange.

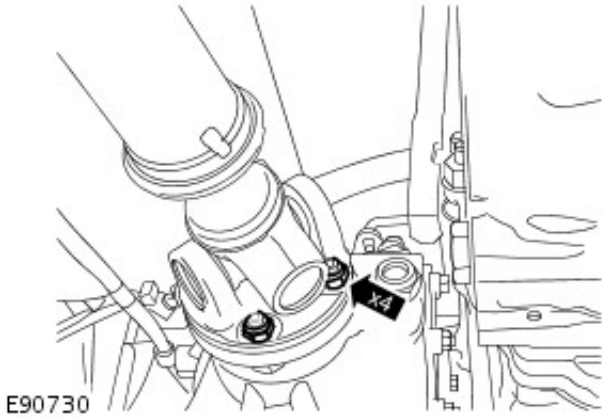


E90729

Release the driveshaft from the front differential.

- Remove and discard the 4 nuts.

3. NOTE: Mark the front driveshaft to transfer case drive flange.



E90730

Remove the driveshaft.

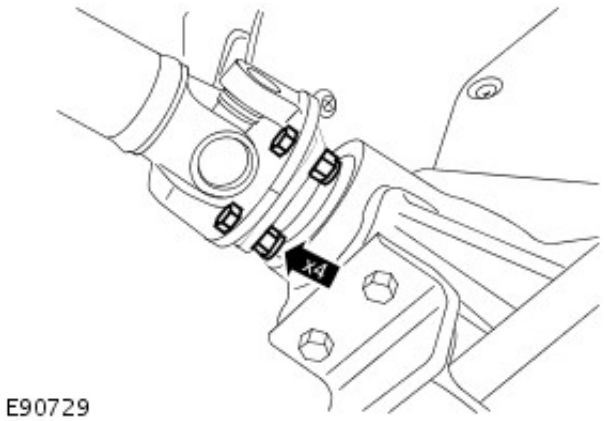
- Remove and discard the 4 nuts.

Installation

1. NOTE: Clean the driveshaft drive flanges and mating faces.

To install, reverse the removal procedure.

2. NOTE: Install new nuts.

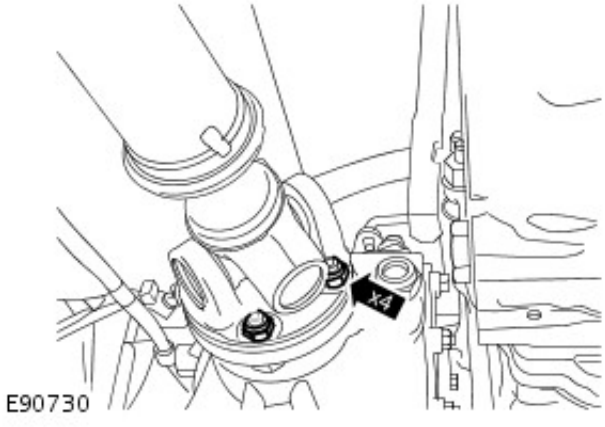


E90729

Tighten to 47 Nm (35 lb.ft).

- Align the position of the driveshaft in relation to the drive pinion flange.

3. NOTE: Install new nuts.



Tighten to 47 Nm (35 lb.ft).

- Align the position of the driveshaft in relation to the drive pinion flange.

Driveshaft - Rear Driveshaft

Removal and Installation

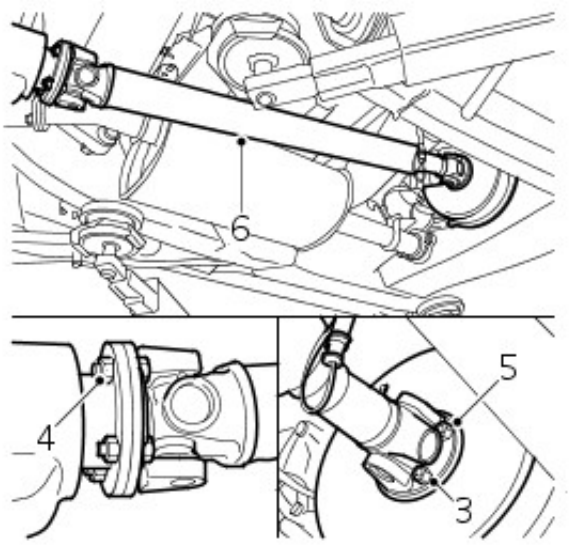
Removal

1. WARNING: Support on safety stands and chock front wheels.

Raise rear of vehicle.

2. NOTE: Mark the rear driveshaft to parking brake flange.

Remove and discard 4 nuts securing driveshaft to parking brake flange.



M470248

- NOTE: Rotation of driveshaft may be required during the above procedure.

3. NOTE: Mark the rear driveshaft to rear differential flange.

- NOTE: Rotation of driveshaft may be required during the procedure.

Remove and discard 4 nuts securing driveshaft to rear axle flange.

4. Release driveshaft from parking brake flange.

5. Remove driveshaft.

Installation

1. Clean driveshaft flange mating faces.

2. Fit driveshaft to park brake flange bolts.

- NOTE: Ensure relationship marks align.

3. Position driveshaft to rear axle flange and fit bolts.

4. NOTE: Rotation of driveshaft may be required during the procedure.

Fit nuts and bolts securing driveshaft to rear axle flange and tighten to 47 Nm (35 lbf.ft).

5. Fit nuts securing driveshaft to park brake and tighten to 50 Nm (37 lbf.ft).

- NOTE: Rotation of driveshaft may be required during the procedure.

6. Remove stands and lower vehicle.

7. Apply parking brake.

Driveshaft - Driveshaft Universal Joint

Disassembly and Assembly

Disassembly

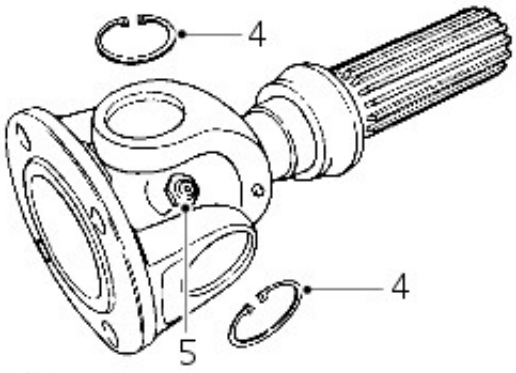
1. Remove driveshaft. For additional information, refer to: (205-01 Driveshaft)

   Front Driveshaft (Removal and Installation),
   Rear Driveshaft (Removal and Installation).

2. Thoroughly examine universal joints for signs of damage or wear.
3. Clean universal joint bearing cups and circlips.

CAUTION: To ensure correct assembly and reduce possibility of imbalance, before removing driveshaft joint mark position of spider pin relative to journal yoke ears.

4. Remove circlips.
5. Note position and remove grease nipple.



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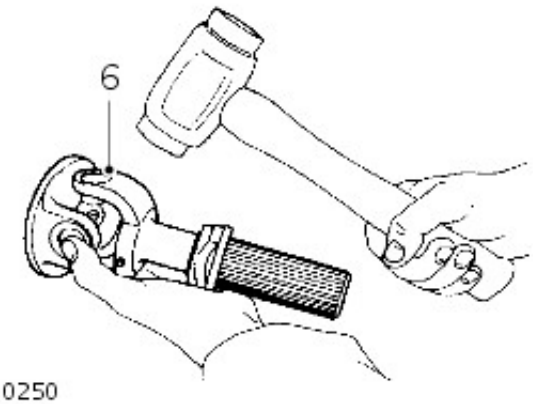
6. Tap yokes to eject bearing cups.



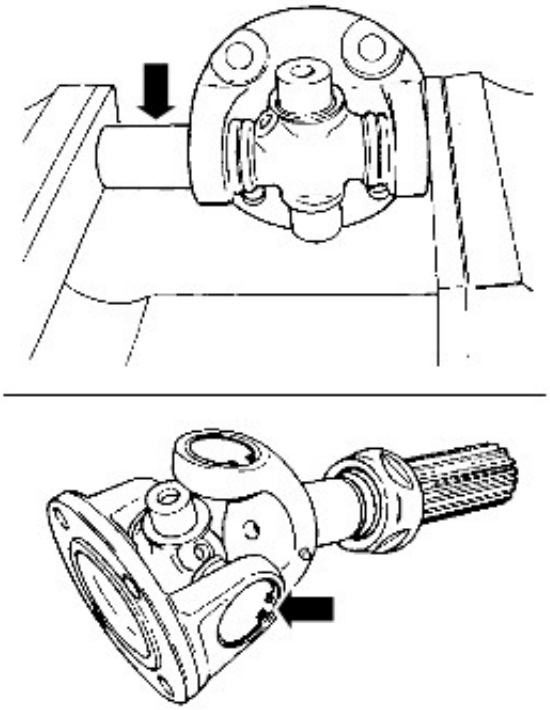
M470250

7. Remove bearing cups.
8. Remove spider.
9. Clean yokes and bearing cup locations.

Assembly

1. Remove bearing cups from new spider.
2. Check all needle rollers are present and positioned in bearing cups.
3. Enter new spider with seals into yokes of propeller shaft

flange.



M470251

4. Partially insert one bearing cup into flange yoke and enter spider trunnion into bearing cup.
5. Insert opposite bearing cup into flange yoke.
6. Press both cups into place.
7. Press each cup into its respective yoke up to lower land of circlip groove. Damage may be caused to cups and seals if cups pass this point.
8. Fit circlips and check no end float exists.
9. Fit grease nipple and lubricate
10. Repeat instructions for opposite end of driveshaft as described in 3 to 9.
11. Fit driveshaft. For additional information, refer to: (205-01 Driveshaft)

    Front Driveshaft (Removal and Installation),
    Rear Driveshaft (Removal and Installation).

Rear Drive Axle/Differential -

Rear axle	
Type	Spiral bevel, fully floating shafts
Ratio	3.54:1

Sealers

Item	Land Rover Part No.
Rear axle differential case	STC 3811
Crown wheel to differential case bolts	STC 50552
Differential case bolts	STC 50552
Hub drive member bolts	STC 50552

Lubricants

Item	Specification
Final drive *	Molytex EP90

*** Do not use any lubricant other than that specified**

Capacities

Unit	Capacity
Differential - 90 Models	1.70 litres (3.0 pints) (1.80 US quarts)
Differential - 110 Models	2.26 Litres (4.00 pints) (2.39 US Quarts)

Torque Specifications

Description	Nm	lb-ft
Pinion housing to axle case	41	30
Crown wheel to differential case	58*	43*
Differential bearing cap to pinion housing	90	65
Differential drive flange to drive shaft	47	34
Bevel pinion nut	129	96
Lower link to axle	176	130
Pivot bracket ball joint to axle	176	130
Brake disc to hub	73*	53*

*** Apply sealant, Part No. STC 50550 to threads**

Rear Drive Axle/Differential - Rear Drive Axle and Differential

Description and Operation

Description

The welded steel rear axle casing houses a separate spiral bevel type differential unit, which is off set to the right of the vehicle centre line. The differential unit drives the rear wheels via the axle shafts and fully floating hubs which are mounted on tapered roller bearings.

Lubrication

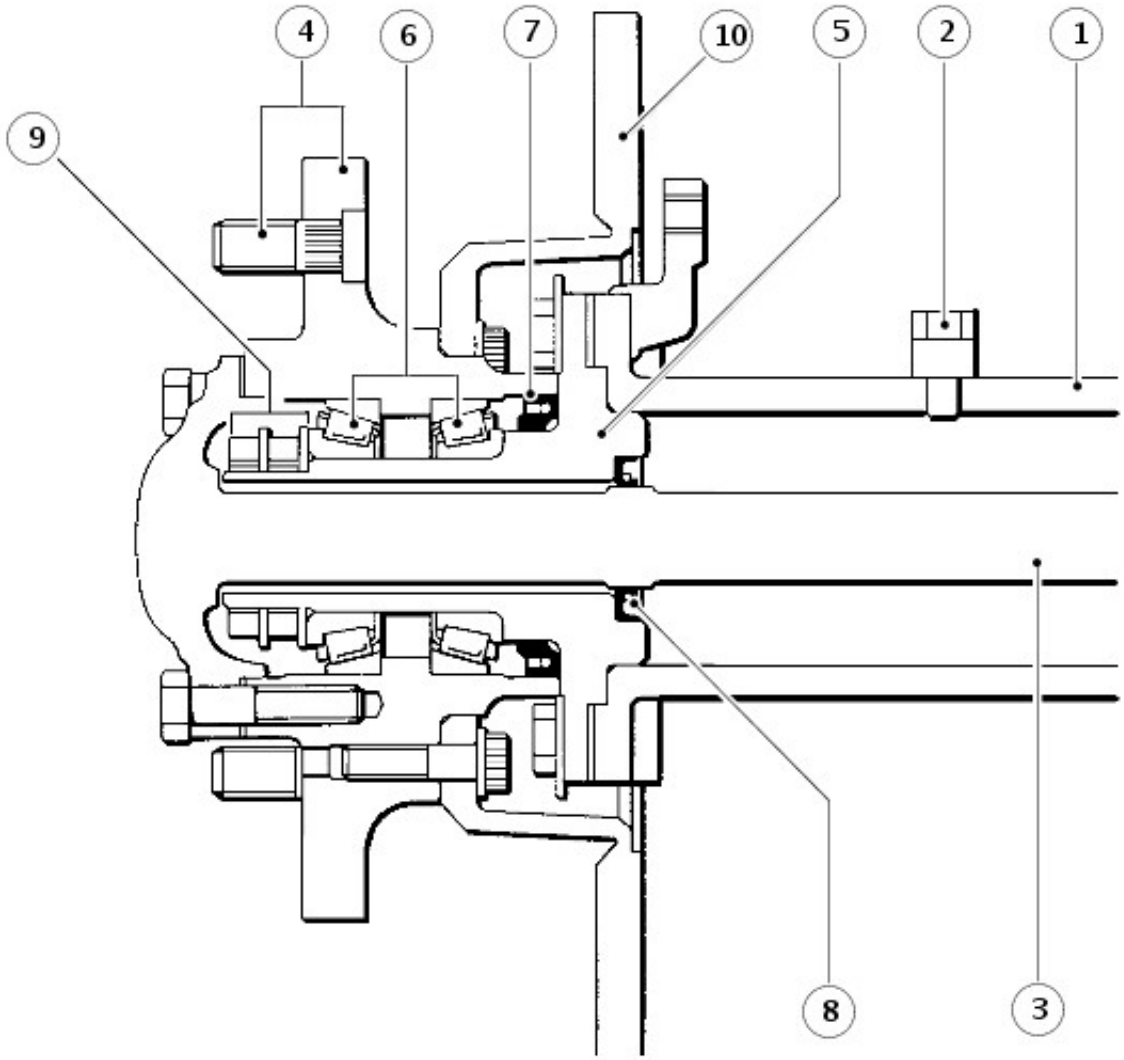
The differential is lubricated with oil and the hub bearings with grease.

The hub bearings are fitted with inner and outer seals. The outer seals prevent the differential oil mixing with the hub grease and the inner seals prevent dirt ingress into the hub.

Ventilation

Ventilation of the hub bearings is through the outer oil seals and the differential ventilation pipe, which terminates at a high level.

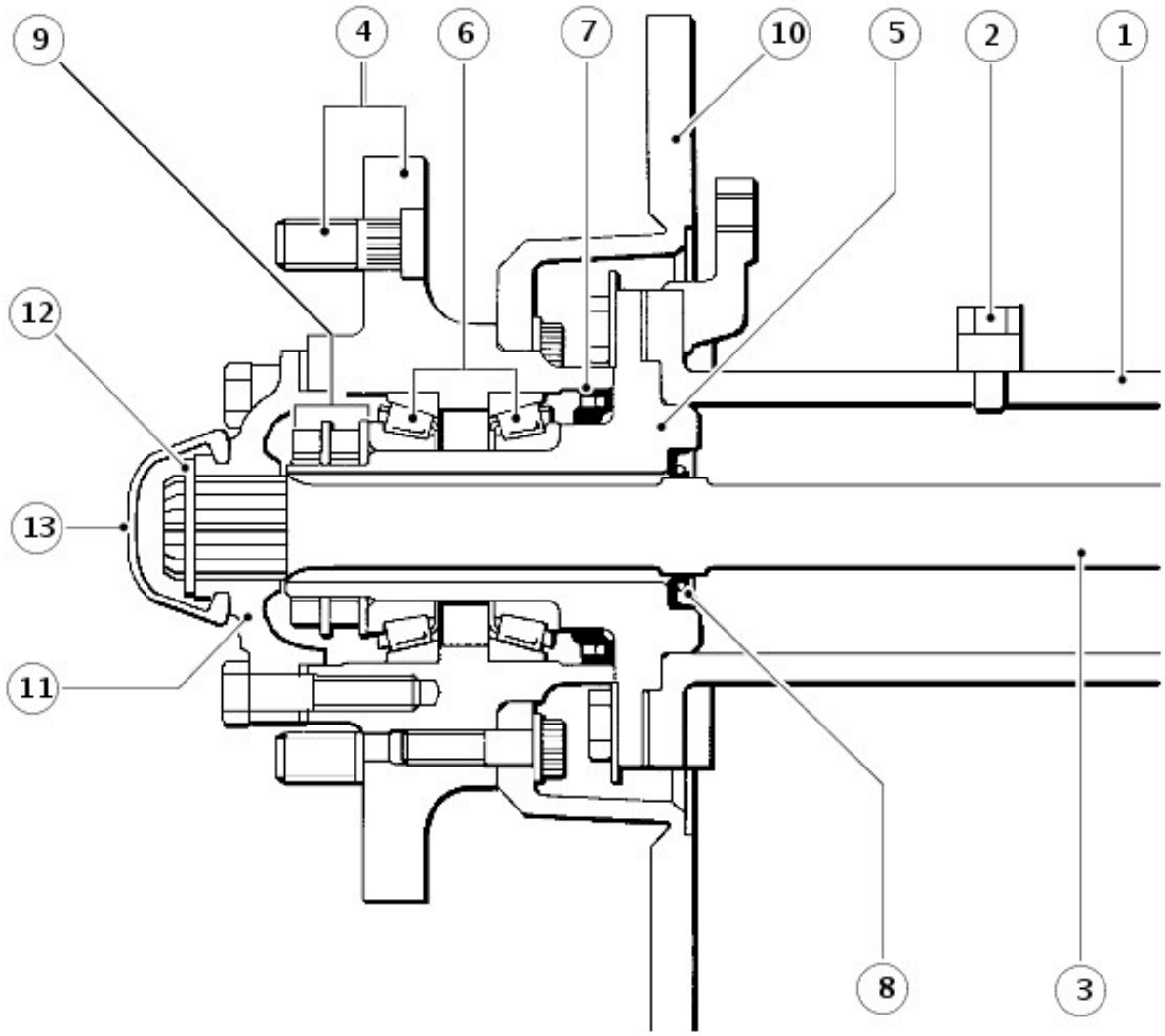
Rear axle hub - 90



J6250A

Item	Part Number	Description
1	-	Axle casing
2	-	Ventilation pipe
3	-	Axle shaft
4	-	Wheel studs and hub
5	-	Wheel bearing stub axle
6	-	Wheel bearings
7	-	Inner hub seal
8	-	Outer hub/axle shaft seal
9	-	Hub lock plate, thrust washer and nuts
10	-	Brake disc

Rear axle hub - 110/130



J6251A

Item	Part Number	Description
1	-	Axle casing
2	-	Ventilation pipe
3	-	Axle shaft
4	-	Wheel studs and hub
5	-	Wheel bearing stub axle
6	-	Wheel bearings

7	-	Inner hub seal
8	-	Outer hub/axle shaft seal
9	-	Hub lock plate, thrust washer and nuts
10	-	Brake disc
11	-	Drive flange
12	-	Drive shaft circlip
13	-	Dust cap

Rear Drive Axle/Differential - Rear Drive Axle and Differential

Diagnosis and Testing

Complaint - Oil leaks

An external leak of lubrication from the hub seals can be caused by a faulty internal seal. For example, if the seals which separate the differential from the hubs are faulty and the vehicle is operating or parked on an embankment, oil from the differential may flood one hub resulting in a lack of lubrication in the differential.

When a seal is found to be leaking check the axle ventilation system, as a blockage can cause internal pressure to force oil past the seals.

Illustrations of oil seal locations are given in Description and Operation.
REFER to: Rear Drive Axle and Differential (205-02 Rear Drive Axle/Differential, Description and Operation).

When investigating hub seal leaks check the grease for dilution with oil. Also check the differential oil level, for signs of metal particles in the oil and the condition of internal seals.

If the vehicle is driven in deep water with defective oil seals, water may contaminate the lubricants and raise the differential oil level, giving a false impression that the housing has been over filled. Do not assume that a high oil level in the differential is due to over filling or, that a low level is because of an external leak.

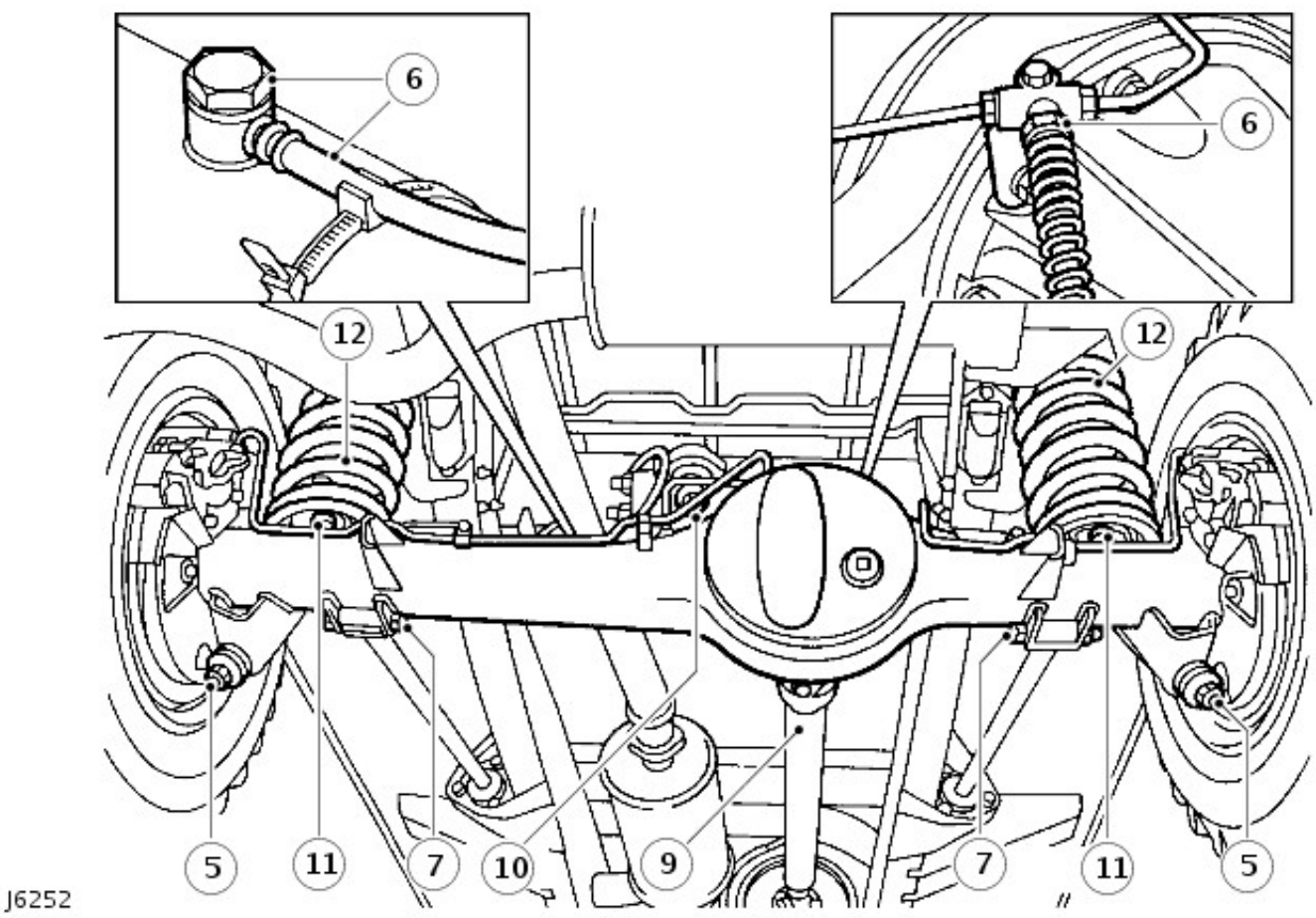
Rear Drive Axle/Differential - Axle Assembly

Removal and Installation

Removal

WARNING: Remove and refit of axle requires a further two persons to steady the axle when lowering or repositioning axle.

1. Drain brake system.



2. Support chassis rear.
3. Remove road wheels.
4. Support axle weight with hydraulic jack.
5. Disconnect shock absorbers.
6. Disconnect flexible brake hose at RH chassis side member and breather hose at banjo connection on axle casing.
7. Disconnect lower links at axle.
8. Mark differential and propeller shaft flanges with identification marks for assembly.
9. Remove 4 nuts and bolts, lower propeller shaft and tie to one side.
10. Disconnect pivot bracket ball joint at axle bracket.
11. Release bolts and remove coil spring retaining plates.
12. Lower axle and remove road springs.
13. If applicable, remove stabilizer bar links at axle. For additional information, refer to: Rear Stabilizer Bar (204-02 Rear Suspension, Removal and Installation).
14. Remove axle assembly.

Installation

1. Position axle and fit lower links. Tighten fixings to 176 Nm (130 lbf.ft).

2. If applicable, fit stabilizer bar links to axle.
   For additional information, refer to: Rear Stabilizer Bar (204-02 Rear Suspension, Removal and Installation).
3. Raise axle and locate road springs.
4. Fit coil spring retaining plates and secure with fixing bolts.
5. Secure pivot bracket ball joint to axle bracket. Tighten fixing to 176 Nm (130 lbf/ft).
6. Align propeller shaft to differential drive flange and tighten fixings to 47 Nm (35 lbf/ft).
7. Reconnect flexible brake hose and axle breather hose.
8. Refit shock absorbers.
9. Fit road wheels and tighten to correct torque: Alloy wheels - 130 Nm (96 lbf/ft) Steel wheels - 100 Nm (80 lbf/ft) Heavy Duty wheels - 170 Nm (125 lbf/ft)
10. Remove rear chassis support.
11. Bleed brake system.
    For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

Front Drive Axle/Differential -

Front axle	
Type	Spiral bevel, enclosed constant velocity joints, fully floating shafts
Ratio	3.54:1
Angularity of universal joint on full lock	32°

Sealers

Front axle and final drive	Land Rover Part No.
Hub retaining bolts	STC 50552
Swivel bearing housing to axle casing bolts	STC 50552
Stub axle bolts	STC 50552
Swivel pin housing grease	STC 3435*

*Swivel pin grease used on later vehicles with filler plug only in swivel pin housing

Lubricants

Item	Specification / Land Rover part number
Final drive	Molytex EP90
Swivel pin	Molytex EP90 OR 80

Do not use any lubricant other than that specified

Capacities

Item	Capacity
Front differential	1.70 litres (3.00 pints) (1.80 US quarts)
Swivel pin housing oil/grease (each)	0.35 litres (0.60 pints) (0.37 US quarts)

Torque Specifications

Description	Nm	lb-ft
Hub driving member to hub	65*	48
Brake disc to hub	73	53
Stub axle to swivel pin housing	65*	48
Brake caliper to swivel pin housing	82	61
Upper swivel pin to swivel pin housing	65*	48
Lower swivel pin to swivel pin housing	25*	18
Oil seal retainer to swivel pin housing	11	8
Swivel bearing housing to axle case	73*	53
Pinion housing to axle case	41	30
Crown wheel to differential housing	58	43
Differential bearing cap to pinion housing	90	65
Differential drive flange to drive shaft	47	34
Mudshield to bracket lower swivel pin	11	8
Bevel pinion nut	130	
Draglink to hub arm	40	30
Panhard rod to axle bracket	88	65
Radius arm to axle	190	140
Radius arm to chassis side member	190	140

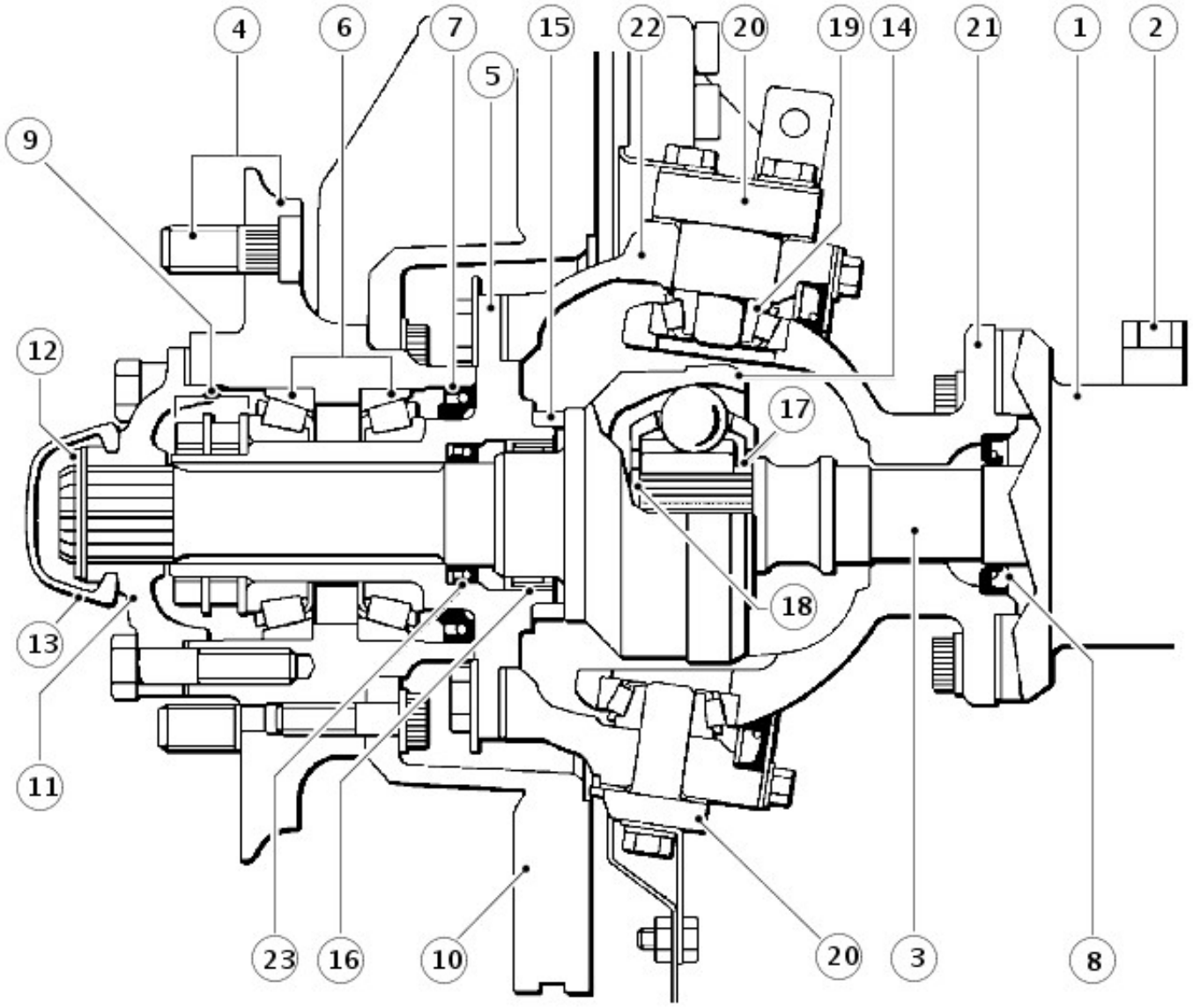
*** Apply sealant, Part No. STC 50552 To bolt threads**

Front Drive Axle/Differential - Front Drive Axle and Differential

Description and Operation

GENERAL

Front axle hub and swivel housing



J6267A

Item	Part Number	Description
1	-	Axle casing
2	-	Ventilation pipe
3	-	Axle shaft
4	-	Wheel studs and hub
5	-	Stub axle
6	-	Wheel bearings
7	-	Inner and outer hub seals
8	-	Axle shaft seal
9	-	Hub lock plate, thrust washer and nuts
10	-	Brake disc
11	-	Drive flange

12	-	Shim washer and circlip
13	-	Dust cap
14	-	Constant velocity joint/shaft
15	-	Thrust collar for CV joint
16	-	Roller bearing
17	-	Spacer
18	-	Circlip
19	-	Top and bottom swivel taper bearing
20	-	Top and bottom swivel pins
21	-	Spherical housing, seal and retainer
22	-	Swivel housing
23	-	Constant velocity shaft seal

The front differential is mounted on the LH side of the chassis.

Operation

The welded steel front axle casing houses a separate spiral bevel type differential unit, which is off-set to the right of the vehicle centre line. The differential unit drives the front wheels via the axle shafts and constant velocity joints which are totally enclosed in the spherical and swivel housings.

The front wheels are pivoted on tape roller bearings at the top and bottom of the swivel housing. The wheel hubs on all axles are supported by two taper bearings and driven by drive flanges which are splined to the one piece, stub shaft/constant velocity joint.

Lubrication

The differential, swivel pin housing and wheel hubs are individually lubricated and separated by oil seals (7) and (8), see J6267A, to prevent oil transfer across the axle when the vehicle is traversing steep inclines. The wheel bearings are lubricated with grease and the swivel housing and differential with oil. On later vehicles, identified by having only a filler plug in the swivel housing, grease is used to lubricate the housing assembly,

Ventilation

Ventilation of the differential is through a plastic pipe (2) which terminates at a high level in the vehicle axle. The swivel housings ventilate through axle shaft oil seals (8) into the differential and the hub bearings vent via the oil seals into the swivel housing.

Front Drive Axle/Differential - Front Drive Axle

Diagnosis and Testing

Complaint - Oil leaks

An external leak of lubrication from the hub seals can be caused by a faulty internal seal. For example, if the seals which separate the differential from the hubs are faulty and the vehicle is operating or parked on an embankment, oil from the differential may flood one hub resulting in a lack of lubrication in the differential.

When a seal is found to be leaking check the axle ventilation system, as a blockage can cause internal pressure to force oil past the seals.

Illustrations of oil seal locations are given in Description and Operation.
REFER to: Front Drive Axle and Differential (205-03 Front Drive Axle/Differential, Description and Operation).

When investigating hub seal leaks check the grease for dilution with oil. Also check the differential oil level, for signs of metal particles in the oil and the condition of internal seals.

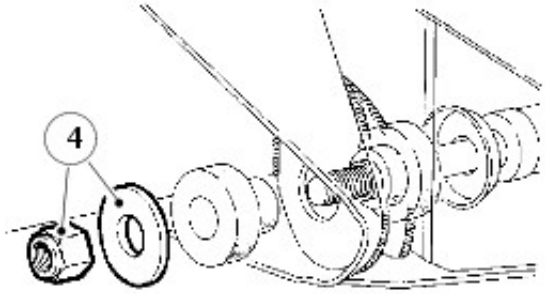
If the vehicle is driven in deep water with defective oil seals, water may contaminate the lubricants and raise the differential oil level, giving a false impression that the housing has been over filled. **Do not assume that a high oil level in the differential is due to over filling or, that a low level is because of an external leak.**

Front Drive Axle/Differential - Axle Assembly

Removal and Installation

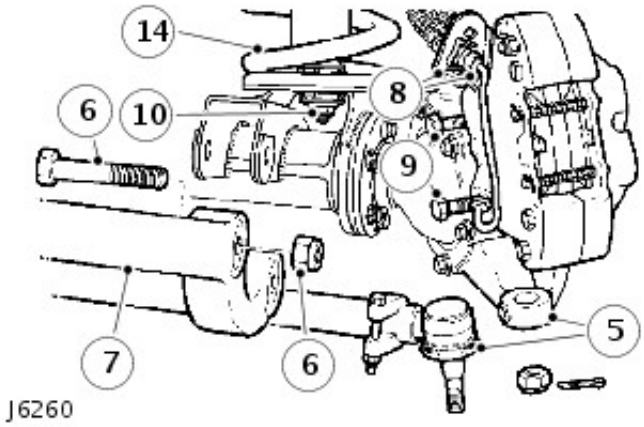
Removal

WARNING: Remove and refit of axle requires a further two persons to steady axle when lowering or repositioning axle.



RR983

1. Support chassis front.
2. Remove road wheels.
3. Support axle weight with hydraulic jack.
4. Remove radius arms to chassis frame nuts.
5. Disconnect steering damper from track rod. Using a extractor remove track rod links from swivel pin arms.
6. Remove four nuts and bolts securing radius arms to axle bracket.
7. Remove radius arms.
8. Remove bolts securing brake hose brackets . Refit bolts to prevent oil leakage.
9. Remove bolts from brake calipers and tie to one side.
10. Remove nuts and washers securing shock absorbers to axle.
11. Disconnect drag link from swivel pin housing arm.
12. Remove two nuts and bolts securing panhard rod to axle bracket. Lift rod clear of axle.
13. Mark for reassembly drive shaft flanges. Remove four nuts and bolts, tie propeller shaft to one side.
14. Release axle ventilation pipe banjo and lower axle assembly. Remove road springs.



J6260

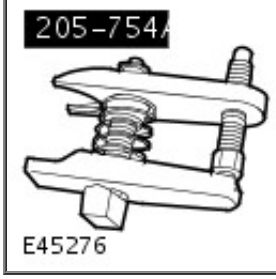
15. Disconnect stabilizer bar link.
    For additional information, refer to: Front Stabilizer Bar Link (204-01 Front Suspension, Removal and Installation).
16. Remove axle assembly.
17. Transfer components to new axle, if appropriate.

Installation

1. Position axle under vehicle, supporting left side of axle, and Instal anti-roll bar links.
   For additional information, refer to: Front Stabilizer Bar Link (204-01 Front Suspension, Removal and Installation).
2. Instal propeller shaft. Tighten bolts to 47 Nm (35 lbf.ft).
3. Instal panhard rod to axle bracket. Tighten bolts to 88 Nm (65 lbf.ft).
4. Instal drag link to swivel pin arm. Tighten fixings to 40 Nm (30 lbf.ft).
5. Instal shock absorbers to axle.
6. Instal brake calipers. Tighten bolts to 82 Nm (60 lbf.ft).
7. Tighten upper swivel pin bolts to 78 Nm (58 lbf.ft).
8. Instal radius arms to axle brackets. Tighten bolts to 197 Nm (145 lbf.ft).
9. Instal steering damper to track rod.
10. Instal radius arms to chassis side member. Tighten fixings to 197 Nm (145 lbf.ft).
11. Tighten track rod end to 40 Nm (30 lbf.ft) and Instal new split pin.
12. Remove chassis supports, Instal road wheels and tighten to correct torque:
    1. Alloy wheels - 130 Nm (96 lbf.ft)
    2. Steel wheels - 100 Nm (80 lbf.ft)
    3. Heavy duty wheels - 170 Nm (125 lbf.ft)

Front Drive Axle/Differential - Differential Carrier

Removal and Installation

Special Tool(s)	
	Ball joint separator 205-754 (LRT-54-027)

Removal

1. CAUTION: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. NOTE: Clean the area around the front axle assembly filler plug and the front axle assembly drain plug.

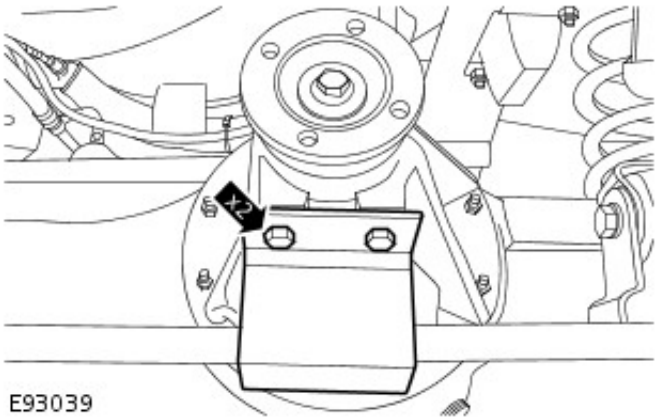
Drain the front axle assembly.

- Position a container to collect the fluid.
- Remove the filler plug.
- Remove the drain plug.

3. Remove the front wheels and tires.

4. Remove the tie rod protector.

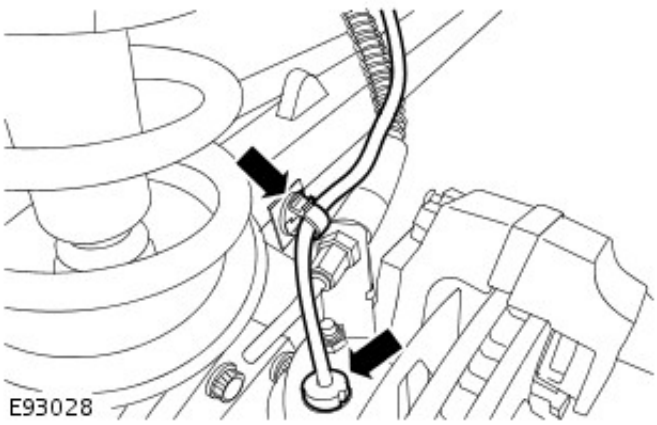
- Remove the 2 bolts.

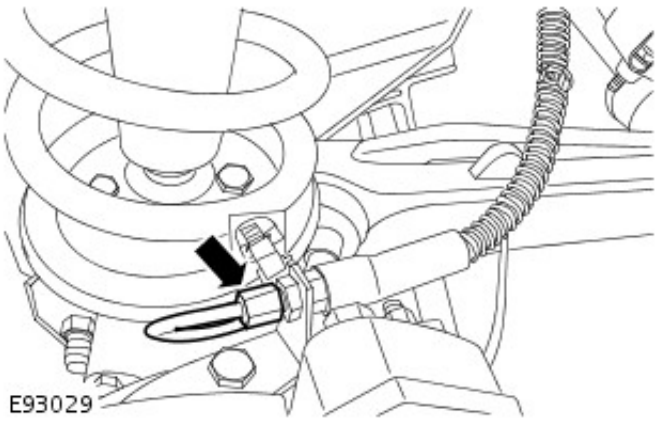


5. CAUTION: Before disconnecting or removing components, make sure the immediate area around joint faces and connections are clean. Plug open connections to prevent contamination.

Release the LH front wheel speed sensor.

- Release the harness from the clip.

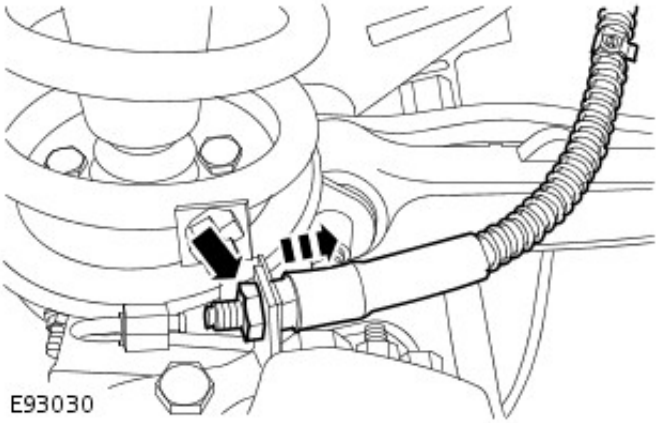




6. CAUTION: Before disconnecting or removing components, make sure the immediate area around joint faces and connections are clean. Plug open connections to prevent contamination.

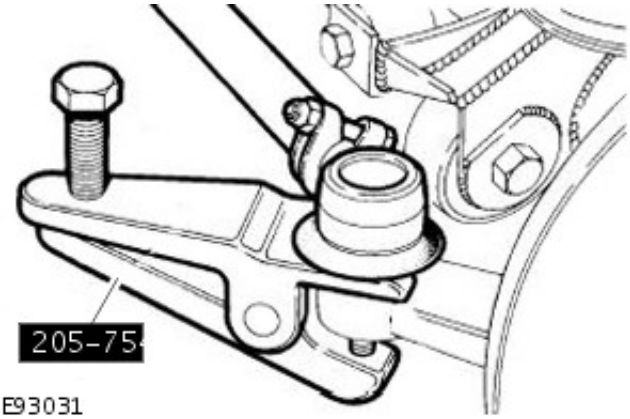
Disconnect the LH front brake pipe.

- Clamp the brake hose to prevent fluid loss.



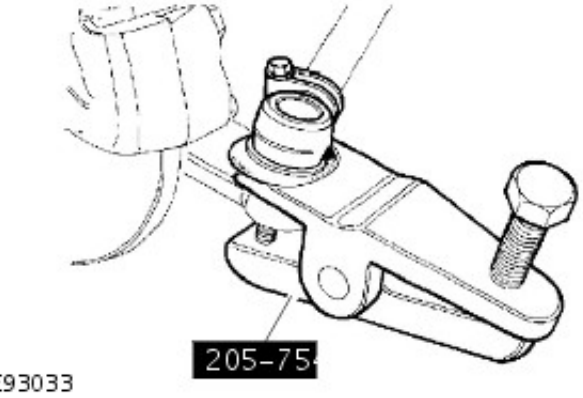
7. Release the LH front brake hose.

- Remove the nut.



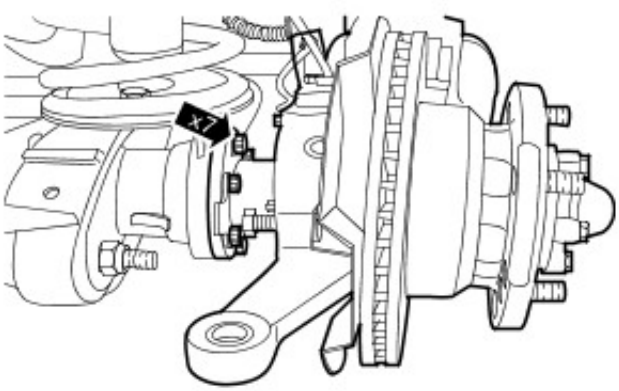
8. Using the special tool, release the drag link end.

- Remove and discard the split pin.
- Remove the nut.
- Collect the washer.



9. Using the special tool, release the LH tie rod end.

- Remove and discard the split pin.
- Remove the nut.
- Collect the washer.

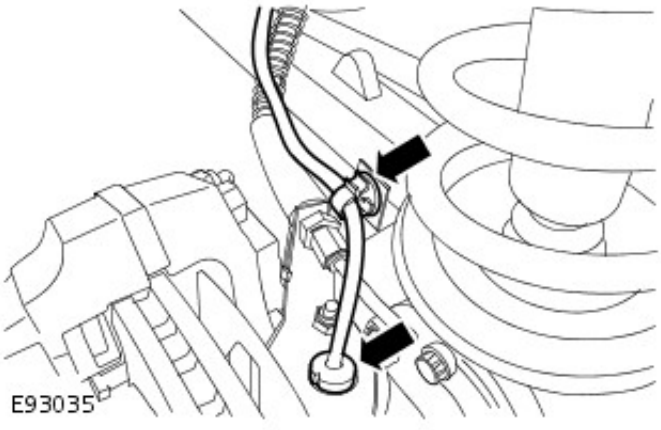


E93034

10. CAUTION: Do not allow the swivel pin housing to hang on the halfshaft, failure to follow this instruction may result in damage to the vehicle.

With assistance, remove the LH swivel pin housing.

- Remove the 7 bolts.
- Remove and discard the gasket.

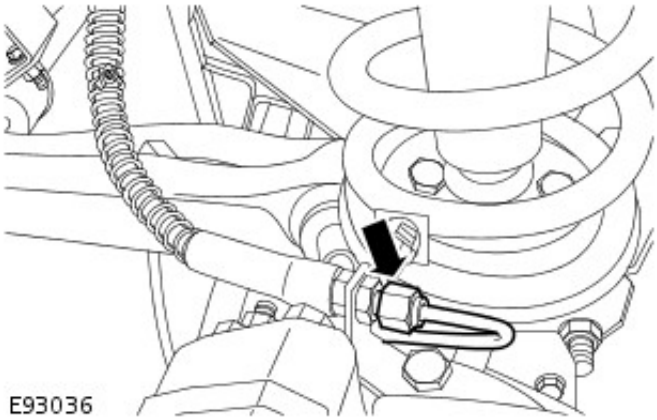


E93035

11. CAUTION: Before disconnecting or removing components, make sure the immediate area around joint faces and connections are clean. Plug open connections to prevent contamination.

Release the RH front wheel speed sensor.

- Release the harness from the clip.

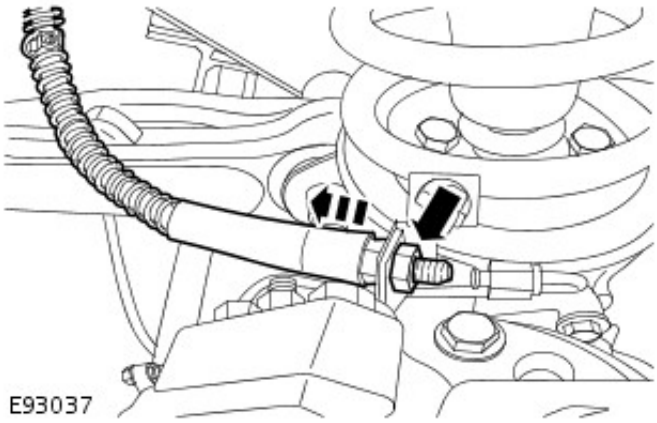


E93036

12. CAUTION: Before disconnecting or removing components, make sure the immediate area around joint faces and connections are clean. Plug open connections to prevent contamination.

Disconnect the RH front brake pipe.

- Clamp the brake hose to prevent fluid loss.

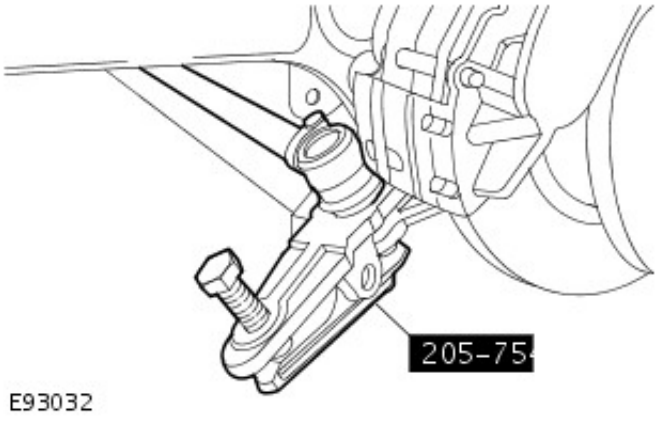


E93037

13. Release the RH front brake hose.

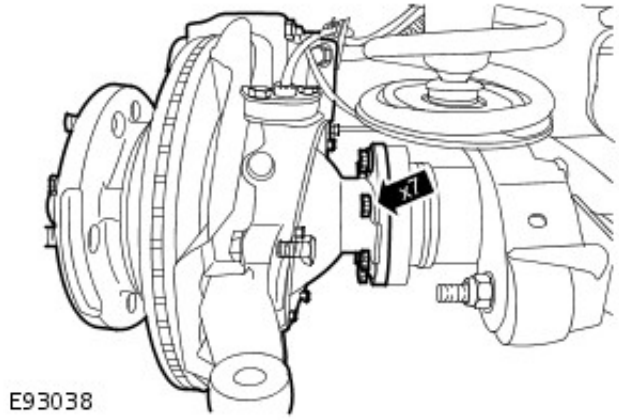
- Remove the nut.

14. Using the special tool, release the RH tie rod end.



E93032

- Remove and discard the split pin.
- Remove the nut.
- Collect the washer.



E93038

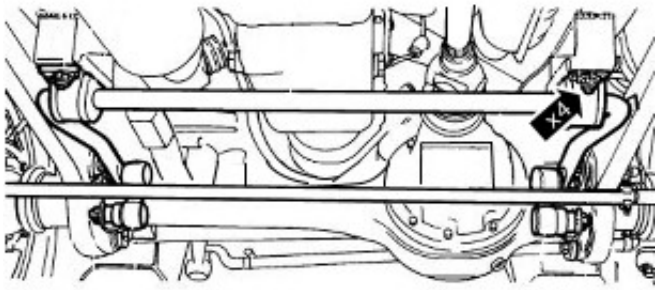
15. CAUTION: Do not allow the swivel pin housing to hang on the halfshaft, failure to follow this instruction may result in damage to the vehicle.

With assistance, remove the RH swivel pin housing.

- Remove the 7 bolts.
- Remove and discard the gasket.

16. NOTE: Discard the nuts.

Reposition the front stabilizer bar.

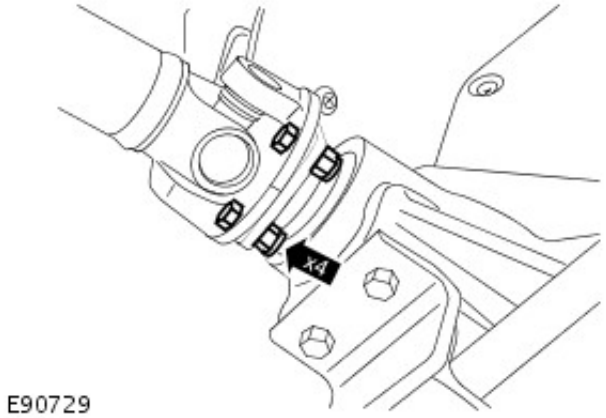


E93040

- Remove the 4 nuts and bolts.

17. NOTE: Discard the nuts.

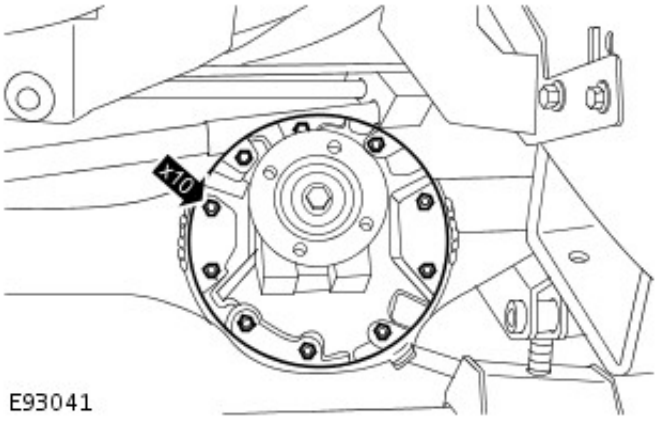
Release the front driveshaft.



E90729

- Remove the 4 nuts and bolts.
- Support the driveshaft using a suitable tie strap.

18. Remove the front differential carrier.



- Remove and discard the 10 nuts.

Installation

1. NOTE: Clean the component mating faces.

• NOTE: Install new nuts.

Install the front differential carrier.

- Apply a bead of the specified sealant to the differential carrier mating face.
- Tighten the nuts to 41 Nm (30 lb.ft).

2. NOTE: Install new nuts.

Secure the front driveshaft.

- Tighten the nuts and bolts to 47 Nm (35 lb.ft).

3. NOTE: Install new nuts.

Secure the front stabilizer bar.

- Tighten the nuts and bolts to 68 Nm (50 lb.ft).

4. CAUTION: Support the weight of the halfshaft when installing the swivel pin housing, failure to follow this instruction may result in damage to the vehicle.

• NOTE: Clean the component mating faces.

With assistance, install the RH swivel pin housing.

- Install a new gasket.
- Apply the specified sealant to the bolts.
- Tighten the bolts to 73 Nm (54 lb.ft).

5. Secure the RH tie rod end.

- Install the washer.
- Tighten the nut to 40 Nm (30 lb.ft).
- Install a new split pin.

6. Secure the RH front brake hose.

- Tighten the nut to 10 Nm (7 lb.ft).

7. NOTE: Remove and discard the blanking caps.

Connect the RH front brake pipe.

- Tighten the union to 15 Nm (11 lb.ft).
- Remove the hose clamp.

8. NOTE: Remove and discard the blanking caps.

Secure the RH front wheel speed sensor.

- Secure the harness in the clip.

9. CAUTION: Support the weight of the halfshaft when installing the swivel pin housing, failure to follow this instruction may result in damage to the vehicle.

• NOTE: Clean the component mating faces.

With assistance, install the LH swivel pin housing.

- Install a new gasket.
- Apply the specified sealant to the bolts.
- Tighten the bolts to 73 Nm (54 lb.ft).

10. Secure the LH tie rod end.

- Install the washer.
- Tighten the nut to 40 Nm (30 lb.ft).
- Install a new split pin.

11. Secure the drag link end.

- Install the washer.
- Tighten the nut to 40 Nm (30 lb.ft).
- Install a new split pin.

12. Secure the LH front brake hose.

- Tighten the nut to 10 Nm (7 lb.ft).

13. NOTE: Remove and discard the blanking caps.

Connect the LH front brake pipe.

- Tighten the union to 15 Nm (11 lb.ft).
- Remove the hose clamp.

14. NOTE: Remove and discard the blanking caps.

Secure the LH front wheel speed sensor.

- Secure the harness in the clip.

15. Install the tie rod protector.

- Tighten the bolts 30 Nm (22 lb.ft).

16. Fill the front axle assembly with the correct amount of the specified oil.

- Install and tighten the drain plug to 60 Nm (44 lb.ft).
- Install and tighten the filler plug to 60 Nm (44 lb.ft).
- Remove the container.

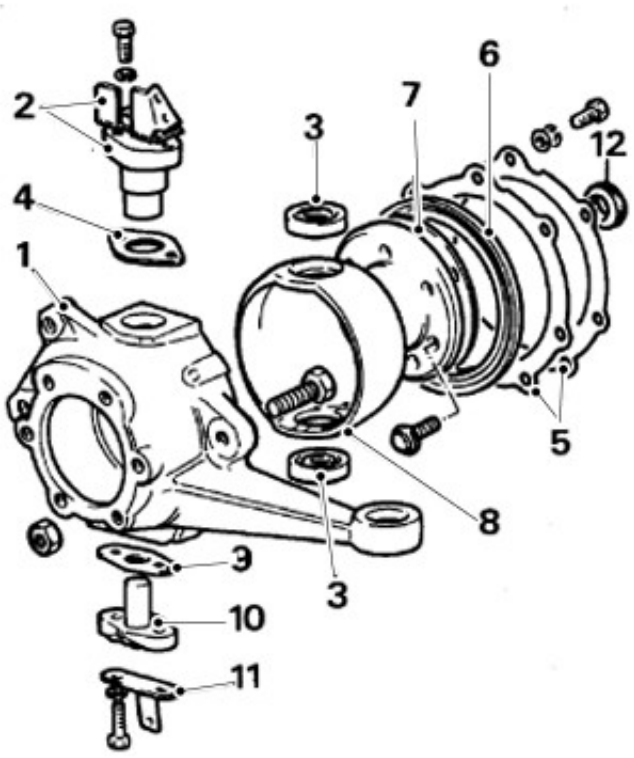
17. Bleed the front brakes.
For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

18. Install the front wheels and tires.

- Tighten the wheel nuts to 140 Nm (103 lb.ft).

Front Drive Axle/Differential - Front Stub Axle, Constant Velocity (CV) Joint and Swivel Pin Housing

Disassembly and Assembly



RR980M

Item	Part Number	Description
1.	-	Swivel pin housing
2.	-	Top swivel pin and brake hose bracket
3.	-	Upper and lower swivel pin bearings
4.	-	Shim
5.	-	Retaining plate and washer
6.	-	Oil seal
7.	-	Joint washer
8.	-	Swivel bearing housing
9.	-	Joint washer
10.	-	Lower swivel pin
11.	-	Mudshield bracket
12.	-	Swivel housing inner oil seal

Disassembly

1. Remove front hub assembly.
For additional information, refer to: Wheel Bearing and Wheel Hub - Vehicles Built Up To: 01/1999 (204-01, Removal and Installation) /
Front Wheel Bearing and Wheel Hub (204-01 Front Suspension, Removal and Installation).

2. NOTE: On later vehicles the swivel pin housing is filled with grease for life, the level and drain plugs being deleted.

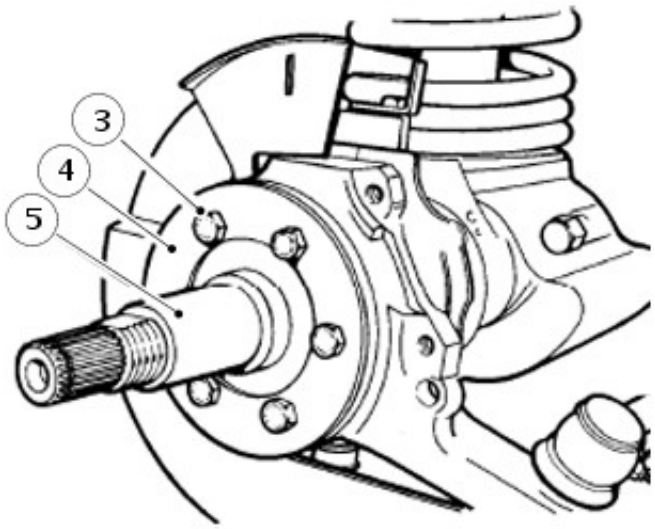
Drain swivel pin housing and refit plug.

3. Remove 6 bolts retaining stub axle to swivel housing.

4. Remove mud shield.

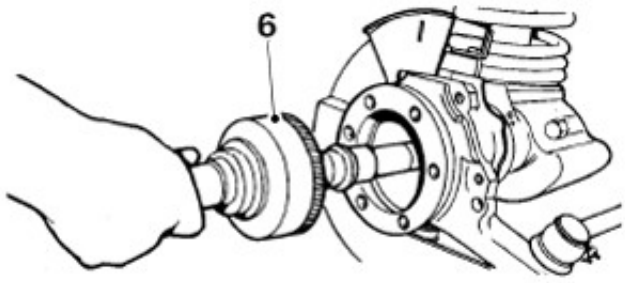
5. Remove stub axle and joint washer.

5. Remove stub axle and joint washer.



J5372M

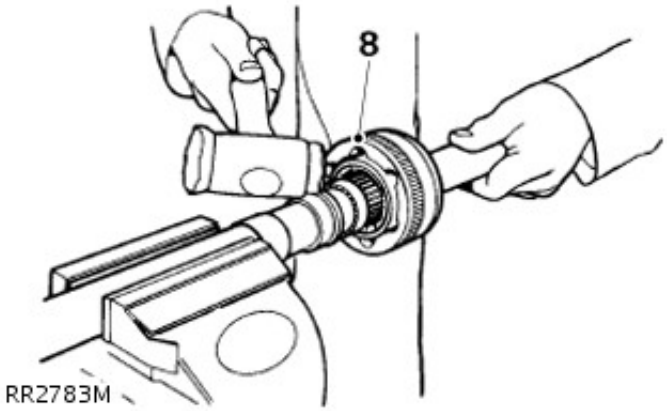
6. Withdraw axle shaft and constant velocity joint from axle casing.



RR2782M

7. Hold axle shaft firmly in a soft jawed vice.

8. Using a soft mallet drive constant velocity joint from shaft.

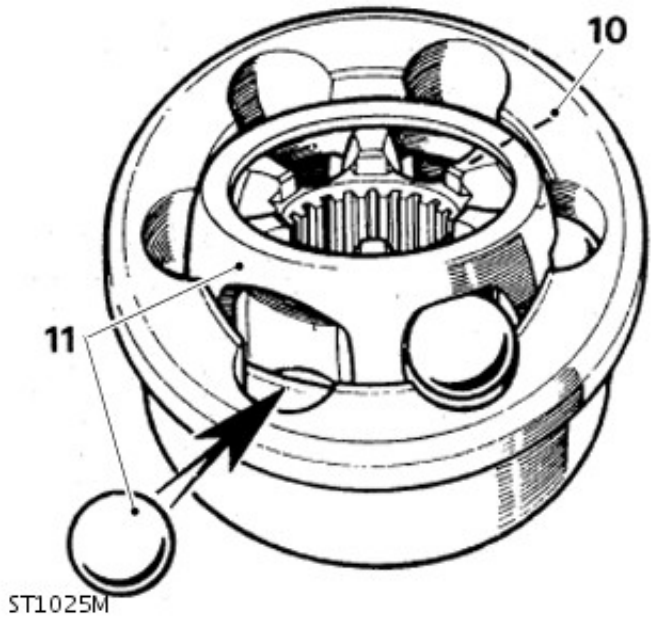


RR2783M

9. Remove circlip and collar from axle shaft.

10. Mark positions of constant velocity joint, inner and outer race and cage for reassembly.

11. Swivel cage and inner race to remove balls.



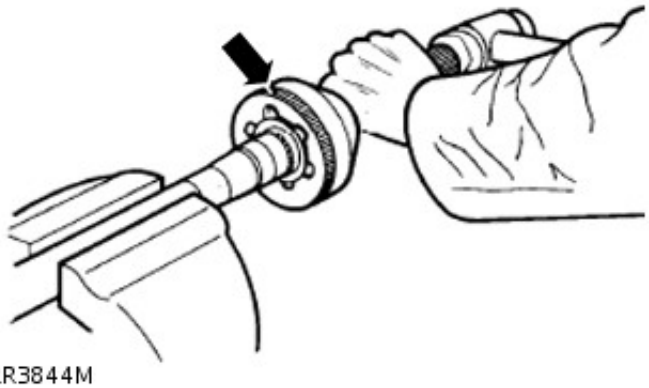
12. Examine all components, in particular, inner and outer track, cage balls and bearing surfaces for damage and excessive wear.

13. Maximum acceptable end-float on assembled joint 0,64mm. Renew if worn or damaged. Lubricate with a recommended oil during assembly.

Assembly

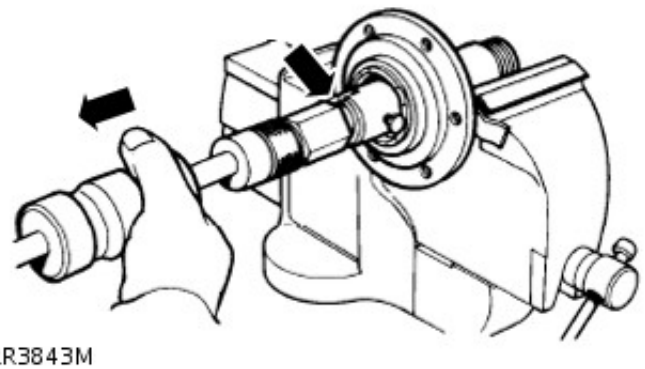
1. Install collar and a new circlip.

2. Engage constant velocity joint on axle shaft splines and using a soft mallet, drive joint in fully.



3. Drill and chisel off thrust ring taking care to avoid damaging stub axle.

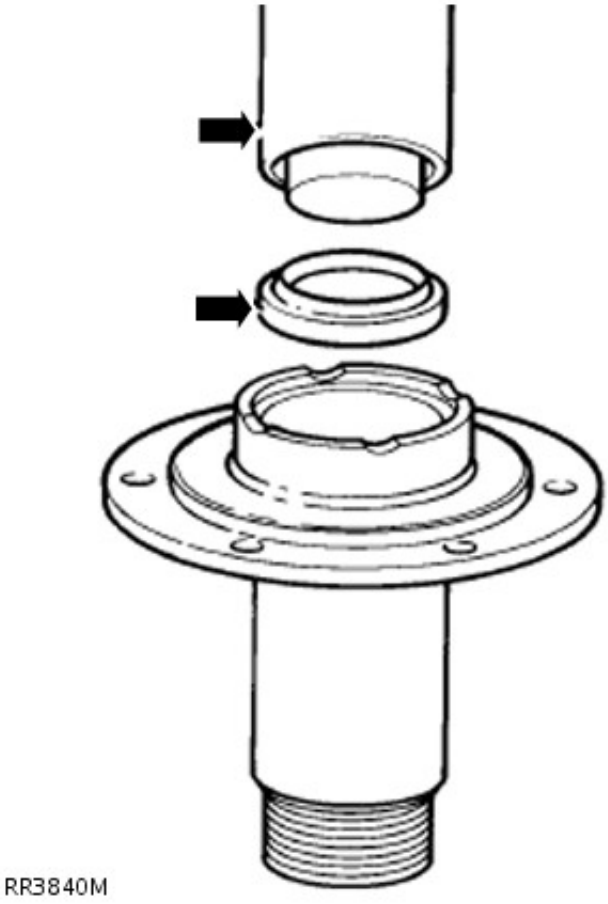
4. Remove bearing and oil seal using special tool LRT-37-004 and slide hammer LRT-99-004. Ensure lip of tool locates behind bearing to drive it out.



5. Repeat instruction for removal of oil seal.

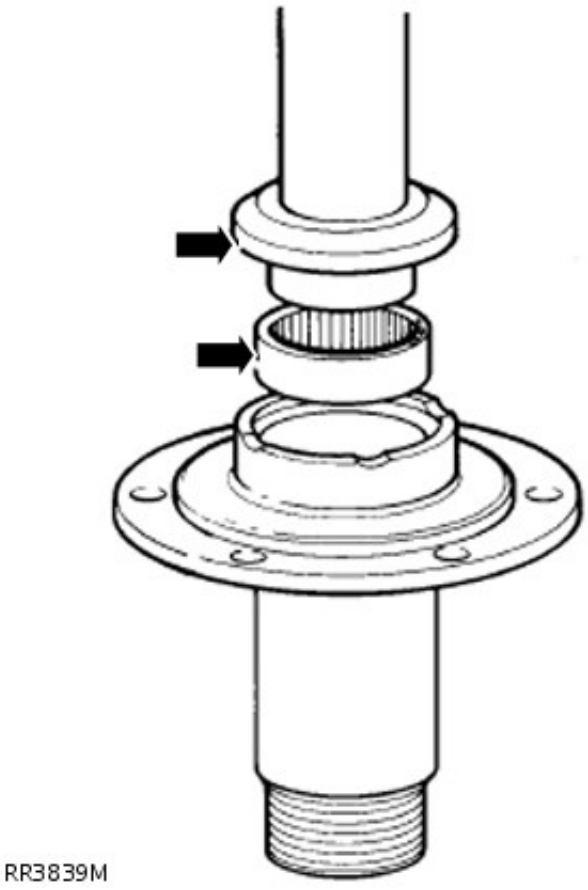
6. Lubricate seal and lip with EP90 oil and with cavity side

leading press in a new oil seal using special tool LRT-54-004.



RR3840M

7. Using special tool LRT-54-005, fit bearing with its part number visible when fitted, and flush with end face of stub axle.



RR3839M

8. Press fit a new thrust ring onto stub axle.

9. NOTE: Removal of oil seal and retaining plate is achieved when swivel bearing housing is removed.

Remove bolts securing oil seal retaining plate and joint

washer. Release assembly from swivel pin housing.

10. Remove 2 bolts, retaining lower swivel pin to housing.

11. Remove brake disc shield bracket.

12. Tap lug to remove lower swivel pin and joint washer.

13. Remove two bolts retaining brake hose bracket and top swivel pin.

14. Remove bracket, top swivel pin and shims.

15. Remove swivel pin housing while retrieving lower and upper bearings.

16. NOTE: Use upper bearing opening to gain access to lower bearing track.

Remove lower bearing track from swivel bearing housing.

17. Remove 7 bolts retaining swivel bearing housing to axle case.

18. Remove inner oil seal from back of housing.

19. NOTE: Use lower bearing opening to gain access to upper bearing track.

Remove top bearing track from swivel bearing housing.

20. If worn, pitted or damaged, renew housing.

21. CAUTION: Ensure bearing tracks are fitted square or damage could occur.

Install upper and lower bearing tracks into swivel bearing housing.

22. With seal lips trailing, install swivel housing inner oil seal into rear of housing. Grease seal lips.

23. Coat swivel bearing housing to axle casing bolts with sealant, Part No. STC 50552.

24. Coat both sides of joint washer with a sealing compound. Position swivel bearing housing to axle mating face.

25. Place retaining plate, joint washer and oil seal over axle flange ready for assembly.

26. Install swivel bearing housing to axle flange with 7 bolts. Tighten to 73 Nm (54 lbf.ft).

27. Grease and install upper and lower swivel pin taper roller bearings.

28. Position swivel pin housing over swivel bearing housing.

29. Coat joint washer both sides with sealing compound and position on lower swivel pin.

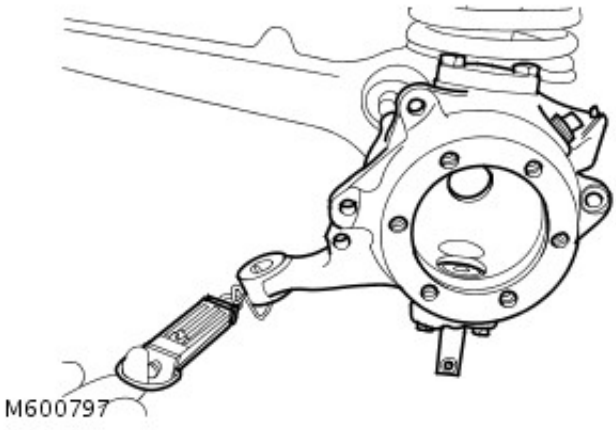
30. Loosely install brake shield bracket plus lower swivel pin with lug outboard to swivel pin housing.

31. Loosely install top swivel pin plus existing shims and brake hose bracket to swivel pin housing.

32. Apply sealant, Part No. STC 50552 to threads of lower swivel pin bolts; tighten bolts to 25 Nm (18 lbf.ft), bend over lock tabs.

33. Apply sealant Part No. STC 50552 to threads of top swivel pin bolts, install bolts and tighten to 65 Nm (48 lbf.ft).

34. NOTE: Swivel housing oil seal and axle should not be



fitted.

Attach a spring balance to track rod ball joint bore and pull balance to determine effort required to turn swivel pin housing. Resistance, once initial inertia has been overcome, should be 1.16 to 1.46 kg. Adjust by removing or adding shims to top swivel pin.

35. When setting is correct remove top swivel bolts, apply sealant, Part No. STC 50552 to threads of bolts. Refit bolts and tighten to 65 Nm (48 lbf.ft), and bend over lock tabs.

36. Apply recommended grease between lips of swivel oil seal.

37. Install oil seal, joint washer and retaining plate with 7 bolts and spring washers. Tighten to 10 Nm (7 lbf.ft).

38. Install tie rod and drag link and secure with new cotter pins. Tighten fixing to 40 Nm (30 lbf.ft).

39. Install brake disc shield.

40. Loosely install lock stop bolt and nut.

41. Apply a recommended grease between lips of swivel housing oil seal.

42. Secure oil seal with retaining plate and securing bolts. Tighten to 10 Nm (7 lbf.ft).

43. Install track-rod and drag link and secure with new cotter pins.

44. Loosely install lock stop bolt for later adjustment.

45. Install brake disc shield.

46. CAUTION: Take care not to damage axle shaft oil seals.

Insert axle shaft, and when differential splines are engaged, push assembly in fully.

47. Place a new joint washer in position on swivel pin housing to stub axle mating face. Coat threads of stub axle bolts with sealant, Part No. STC 50552.

48. CAUTION: Ensure that constant velocity joint bearing journal is butted against thrust ring on stub axle before stub axle is secured.

Install stub axle with flat at 12 O'clock position.

49. Place mud shield in position and secure stub axle to swivel pin housing with 6 bolts and tighten evenly to 65 Nm (48 lbf.ft).

50. Install brake jump hoses to brake jump hose bracket.

51. Install complete front hub assembly.
For additional information, refer to: Wheel Bearing and Wheel Hub - Vehicles Built Up To: 01/1999 (204-01, Removal and Installation) /
Front Wheel Bearing and Wheel Hub (204-01 Front Suspension, Removal and Installation).

52. Check swivel pin housing oil drain plug is fitted.

53. Remove swivel pin level and filler plugs.

54. NOTE: On later vehicles fill swivel pin housing with 0.33 Litres of Molytex EP 00 grease.

Check and top up with new oil until oil runs out from level hole. Allow excess oil to drain and wipe clean.

For additional information, refer to: Specifications (205-03 Front Drive Axle/Differential, Specifications).

55. Install swivel pin level and filler plugs.

56. Set steering lock stop bolts.
For additional information, refer to: Steering Lock Stop Adjustment (211-00 Steering System - General Information, General Procedures).

Brake System - General Information -

Brake Hydraulic Fluid

Item	Specification
* Recommended hydraulic fluid	SHELL DONAX YB DOT4 ESL FLUID

CAUTION: * If the above fluid is not available, use a low viscosity DOT 4 brake fluid meeting ISO 4925 Class 6 and Land Rover LRES22BF03 requirements.

General Specification

• NOTE: Pressure reducing valves are not fitted to all 110 specifications.

Item	Specification
Front caliper	AP Lockheed, four opposed pistons
Operation	Hydraulic, self adjusting
Front disc:	
- 90 Models	Solid, outboard
- 110/130 Models	Ventilated, outboard
Disc diameter	298 mm (11.73 in)
Front disc thickness:	
- 90 Models	14.1 mm (0.56 in)
- 110/130 Models	24 mm (0.95 in)
Wear limit	1 mm (0.04 in) per side of disc
Disc run-out maximum	0.15 mm (0.006 in)
Pad area	58 cm² (9.0 in²)
Total swept area	801.3 cm² (124.2²)
Pad material	Ferodo 3440 non asbestos
Pad minimum thickness	3 mm (0.12 in)
Rear caliper	AP Lockheed, four opposed pistons
Operation	Hydraulic, self adjusting
Rear disc	Solid, outboard
Rear disc diameter:	
- 90 Models	290 mm (11.42 in)
- 110/130 Models	298 mm (11.73 in)
Rear disc thickness:	
- 90 Models	12.5 mm (0.49 in)
- 110/130 Models	14.1 mm (0.56 in)
Wear limit:	
- 90 Models	0.38 mm (0.015 in) per side of disc
- 110/130 Models	1 mm (0.04 in) per side of disc
Disc run-out maximum	0.15 mm (0.006 in)
Pad area:	
- 90 Models	30.5 cm² (4.37 in²)
- 110/130 Models	36.2 cm² (5.61 in²)
Total swept area	694 cm² (106.98 in²)
Pad material	Ferodo 3440 non asbestos
Pad minimum thickness	3 mm (0.12 in)
Parking brake	
Parking brake type	Mechanical, cable operated drum brake on the rear of the transfer gearbox output shaft
Parking brake drum internal diameter	254 mm (10.0 in)
Width	70 mm (2.75 in)
Pad material	Ferodo 3611 non asbestos
Master cylinder/Booster	
Master cylinder manufacturer	Lucas
Master cylinder type	Tandem, 25.4 mm (1.0 in) diameter
Booster type	LSC 80
Pressure reducing valve, failure conscious:	
- 90 Models	Cut-in pressure 24 bar (360 lbf/in²), ratio 4.0:1
- 110/130 Models	Cut-in pressure 43 bar (645 lbf/in²), ratio 2.9:1

Torque specifications

Description	Nm	lbf-ft
Brake pipe to pressure reducing valve	15	11
Brake pipe to brake calipers	15	11
Brake pipe to master cylinder	15	11

Flexible hoses to calipers	15	11
Bleed screws	15	11
Brake caliper to swivel pin housing	82	60
Brake disc bolts*	73	54
Brake drum screw	8**	6
Brake drum adjuster bolt	25	18
Booster assembly to pedal box	26	19
Pedal box to bulkhead	25	18
Master cylinder to booster	26	19

* Apply Loctite 270 before assembly

**If you are refitting old screws, tighten to 25 Nm (18 lbf-ft).

Brake System - General Information - Brake System

Description and Operation

Master cylinder description

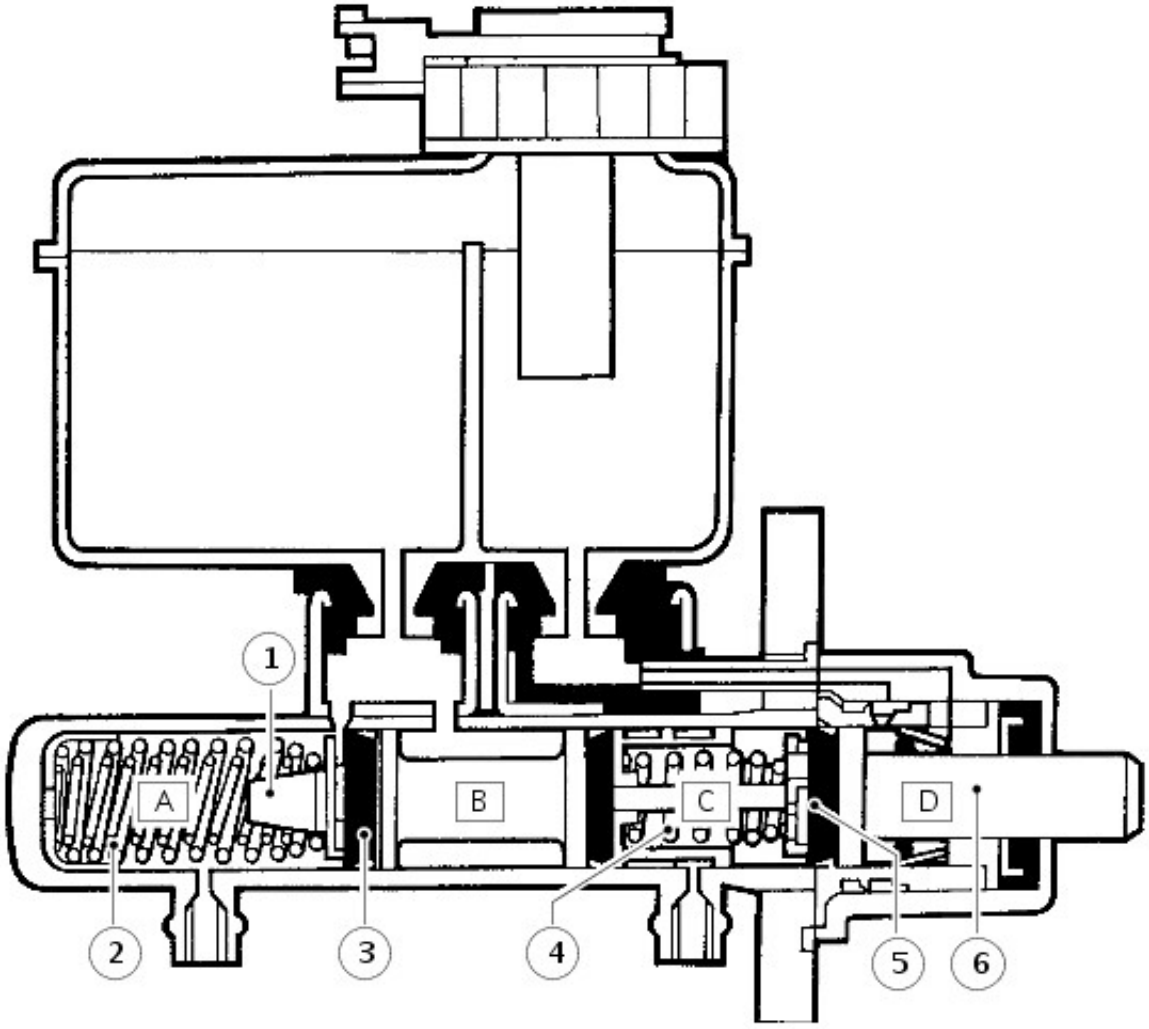
The mechanical components of the hydraulic braking system consists of four piston caliper disc brakes at the front and two piston caliper disc brakes at the rear.

Vented front brake discs are fitted as standard on 110/130 models, while 90 models have solid discs. However, on 90 models with a heavy duty chassis, vented front discs may also be fitted.

A cable controlled parking brake operates a single drum brake mounted on the output shaft of the transfer gearbox and is completely independent of the main braking system.

The basic hydraulic system involves 2 separate and independent primary and secondary circuits which permits a degree of braking should a fault occur in one of the circuits. The primary circuit operates the rear brake calipers and the secondary circuit the front brake calipers.

Master cylinder components



J6321

Item	Part Number	Description
1	-	Secondary plunger

2	-	Secondary spring
3	-	Recuperation seal
4	-	Primary spring
5	-	Recuperation seal
6	-	Primary plunger

Master cylinder operation

A tandem master cylinder, which is assisted by a light weight, short, compact servo, is fed by a divided fluid reservoir. The rear section supplies fluid for the primary circuit and the front section the secondary circuit.

When the brakes are off, the fluid can move unrestricted between the dual line system and the separate reservoirs in the fluid supply tank.

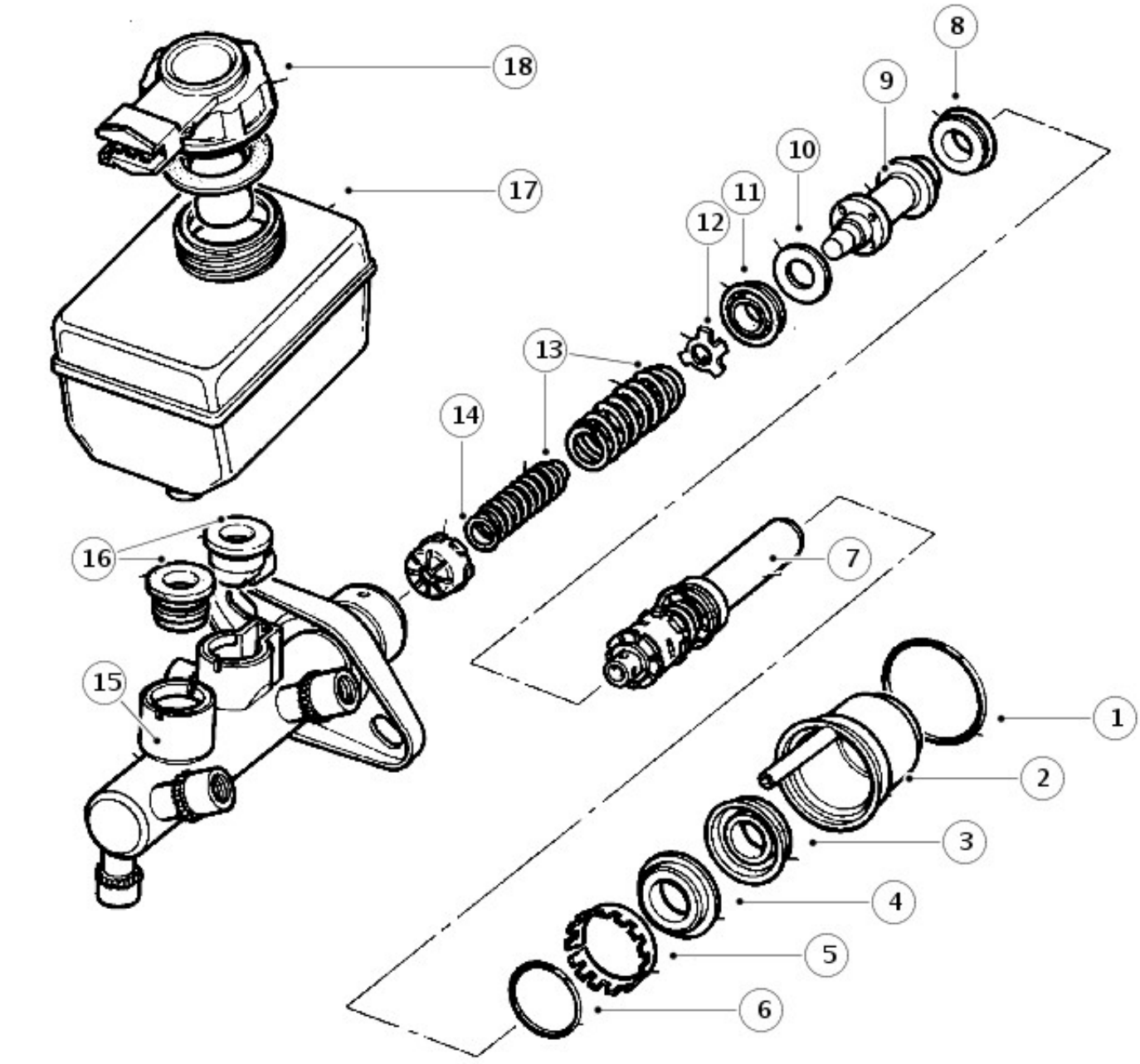
When the footbrake is applied, the primary plunger assembly moves up the cylinder bore and the pressure created acts in conjunction with the primary spring to overcome the secondary springs, thus moving the secondary plunger assembly up the bore. At the same time initial movement of both plungers takes the recuperating seals past the cut-off holes in the cylinder chambers 'A' and 'C', see J6321, and applies pressure to the fluid in those chambers, which is directed to the respective circuits.

The fluid in chambers 'B' and 'D' is unaffected by movement of the plungers and can move unrestricted between the separate chambers and respective reservoirs in the fluid supply tank, both before and during brake application. When the brakes are released, the plunger assemblies, aided by the return springs are retracted faster than the fluid; this creates a depression between the fluid in chambers 'A' and 'C' and the recuperation seals.

The recuperation seals momentarily collapse allowing fluid in chambers 'B' and 'D' to flow through the holes in the plungers, over the collapsed seals and into chambers 'A' and 'C' respectively. The movement of fluid from one set of chambers to the other, is compensated for by fluid from the separate reservoirs in the supply tank moving through the feed holes in the cylinder. Conversely, the final return movement of the plunger assemblies causes the extra fluid in chambers 'A' and 'C' to move through the cut off holes into the fluid reservoir.

The servo unit provides controlled power assistance to the brake pedal when pressure is applied. Power is obtained from a vacuum pump located on the RH side of the engine cylinder block. The vacuum is applied to both sides of a flexing diaphragm, and by admitting atmospheric pressure to the rear diaphragm, assistance is obtained. The servo unit is mounted between the brake pedal and master cylinder and is linked to these by push rods. Should a vacuum failure occur, the two push rods will act as a single rod allowing the brakes to function in the normal way, although more effort will be required to operate the brake pedal.

Master cylinder overhaul components



ST3324M

Item	Part Number	Description
1	-	Water ingress seal
2	-	Transfer housing
3	-	Vacuum seal
4	-	Guide ring
5	-	Retaining ring
6	-	O-ring seal
7	-	Primary plunger assembly
8	-	'L' seal
9	-	Secondary plunger
10	-	Washer
11	-	Recuperating seal (primary cup)
12	-	Seal retainer
13	-	Springs
14	-	Swirl tube
15	-	Master cylinder body
16	-	Reservoir seals
17	-	Reservoir
18	-	Low fluid level switch and cap

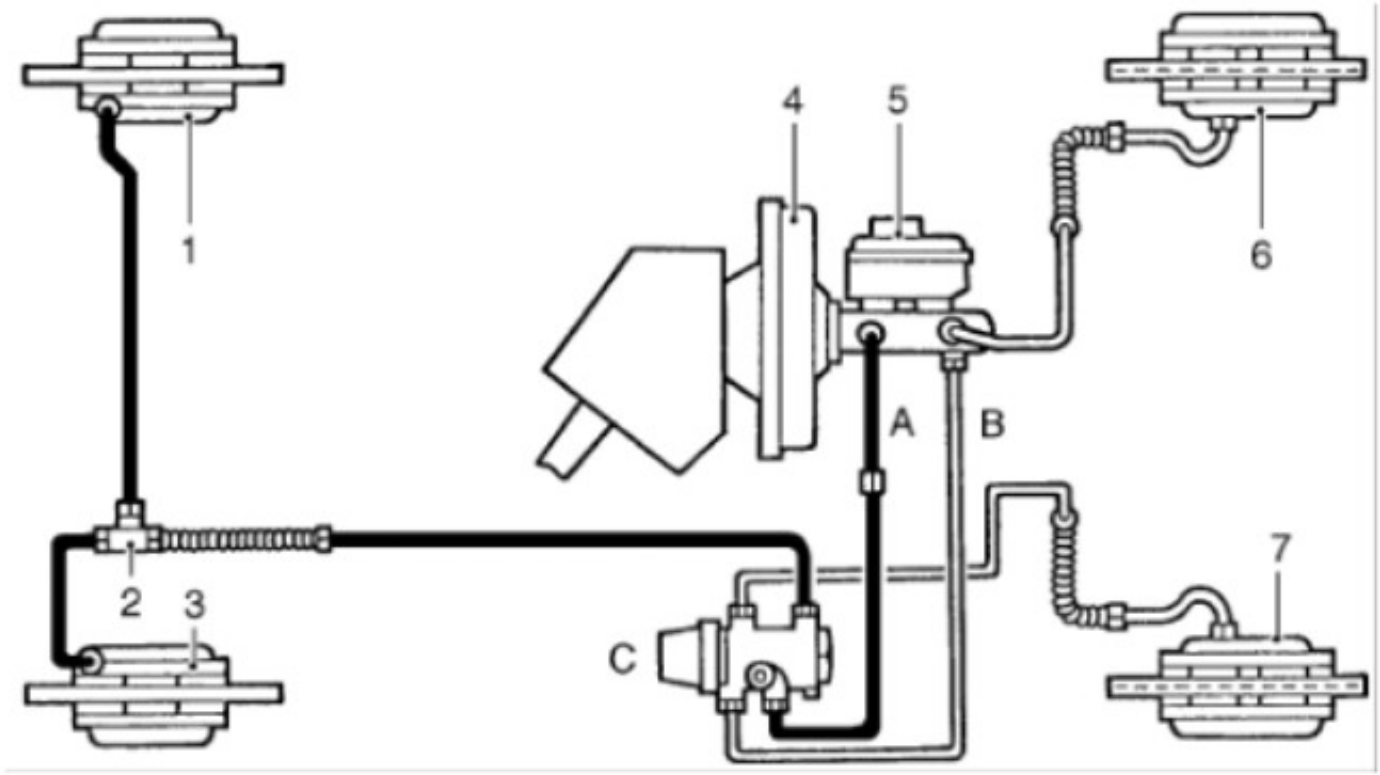
Hydraulic system

The brake system should be drained and flushed at the recommended service intervals.

A brake fluid loss switch is fitted to the master cylinder reservoir filler cap. The switch is wired to a warning light on the vehicle fascia and will illuminate as a bulb check when the ignition is switched on and extinguishes when the engine is running and the handbrake is released. A hydraulic failure in the system will result in fluid loss, causing the warning light to illuminate.

On 90 models a pressure reducing valve (PRV), fitted to the RH bulkhead in the engine compartment, maintains the braking balance, see J6322. Pressure to the rear calipers is regulated by the PRV, this valve is of the failure by-pass type, allowing full system pressure to the rear brake calipers in the event of a front (secondary) circuit failure.

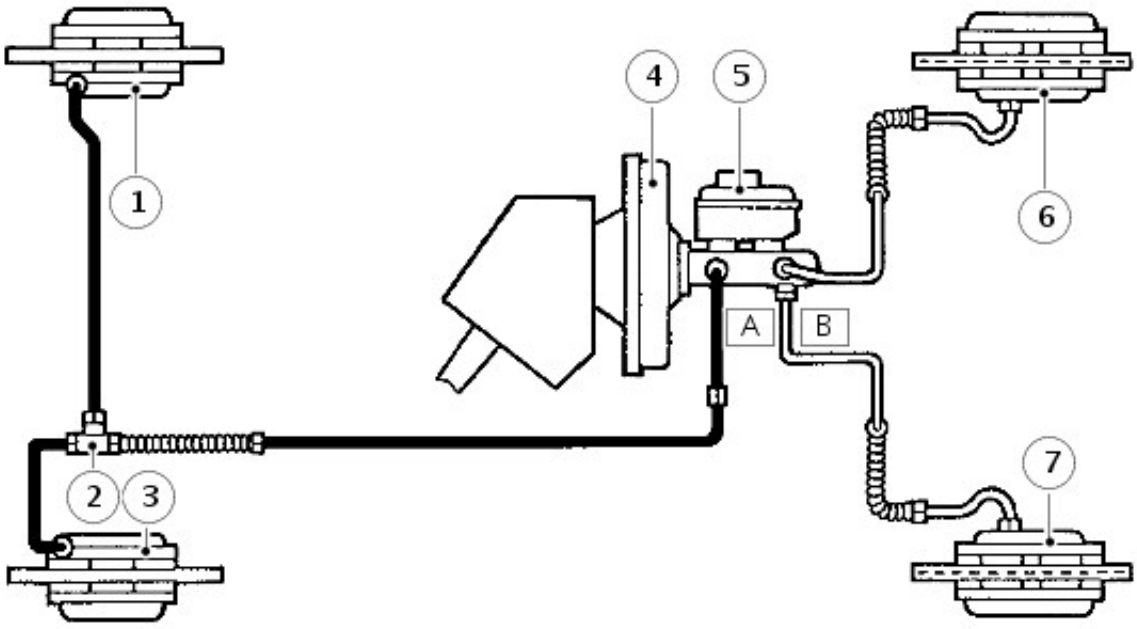
90 Models



J6322

110/130 Models

• NOTE: In some countries, a pressure reducing valve may be fitted to 110 models to conform to legal requirements.

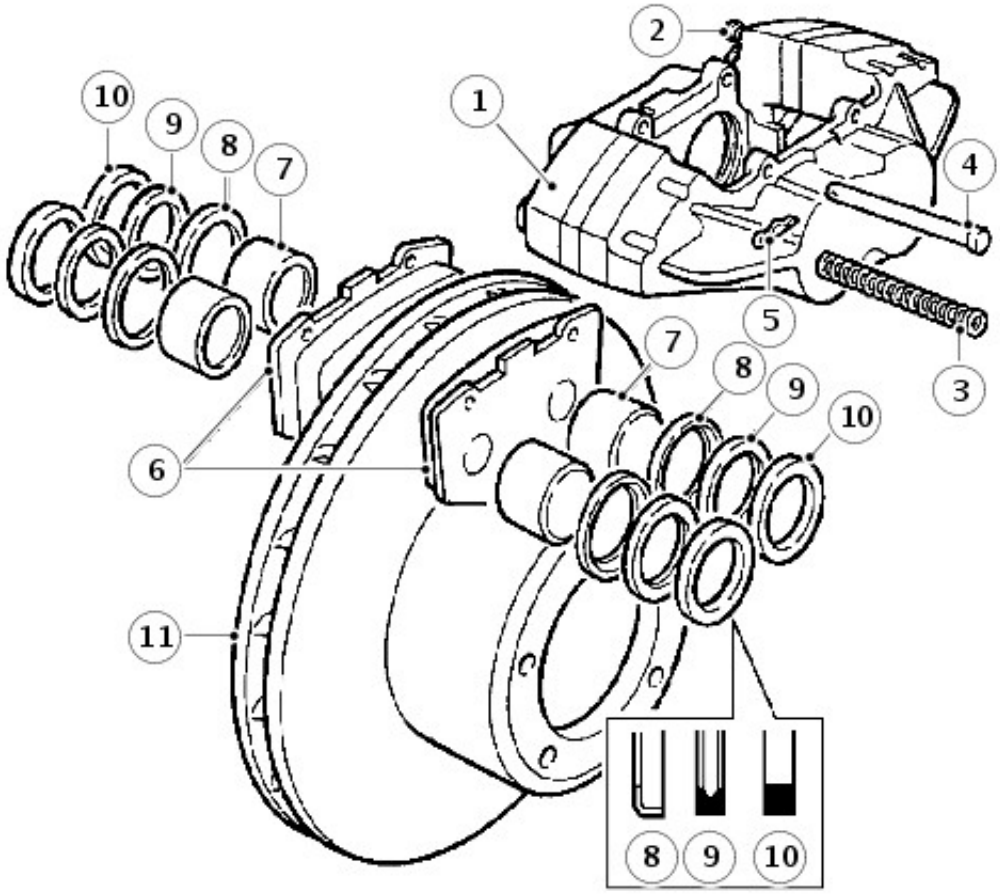


J6323

Item	Part Number	Description
A	-	Primary circuit
B	-	Secondary circuit
C	-	Pressure reducing valve
1	-	LH rear brake caliper
2	-	T Connector
3	-	RH rear brake caliper
4	-	Brake servo
5	-	Master cylinder and reservoir
6	-	LH front brake caliper
7	-	RH front brake caliper

Front brake caliper assembly

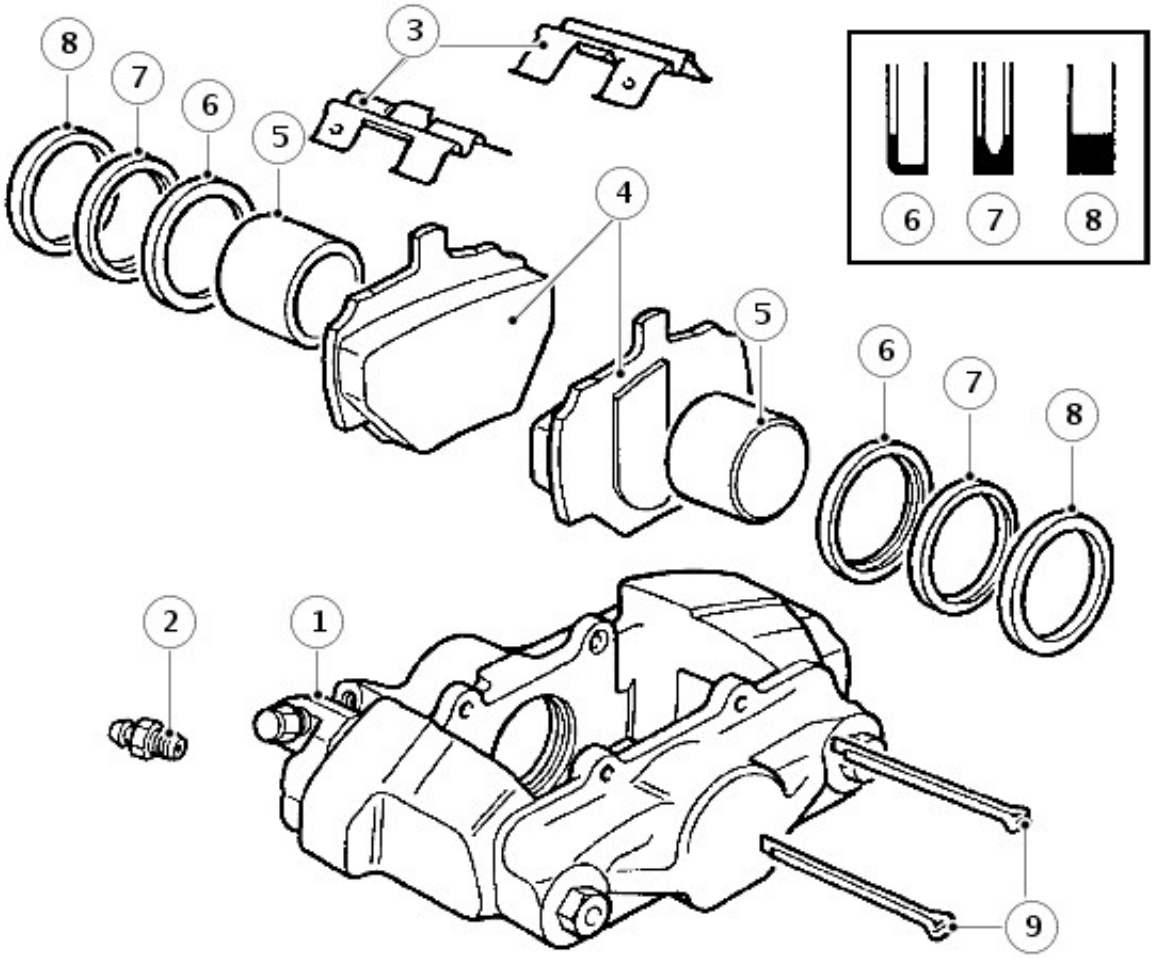
Front brake caliper components



Item	Part Number	Description
1	-	Caliper
2	-	Bleed screw
3	-	Anti-rattle springs
4	-	Pad retaining pins
5	-	Split pin
6	-	Friction pads
7	-	Piston
8	-	Wiper seal retainer
9	-	Wiper seal
10	-	Fluid seal
11	-	Brake disc

Rear brake caliper assembly

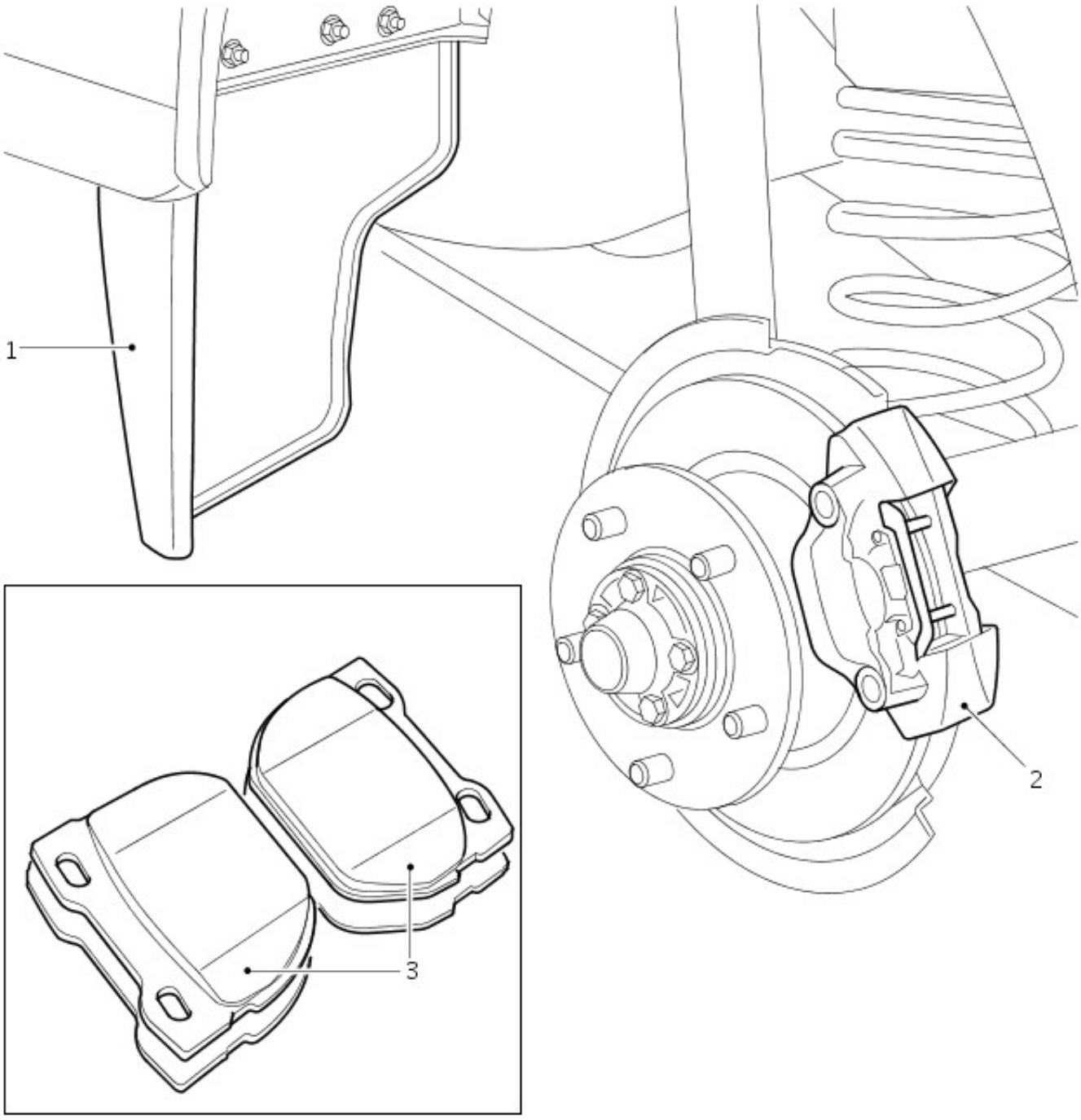
Rear brake caliper components



J6335

Item	Part Number	Description
1	-	Caliper
2	-	Bleed screw
3	-	Pad retaining springs
4	-	Brake pads
5	-	Piston
6	-	Wiper seal retainer
7	-	Wiper seal
8	-	Fluid seal
9	-	Retraining pins

Rear brake caliper installation - From 02MY



M701106A

Item	Part Number	Description
1	-	Deflector
2	-	Rear brake caliper
3	-	rear brake pads

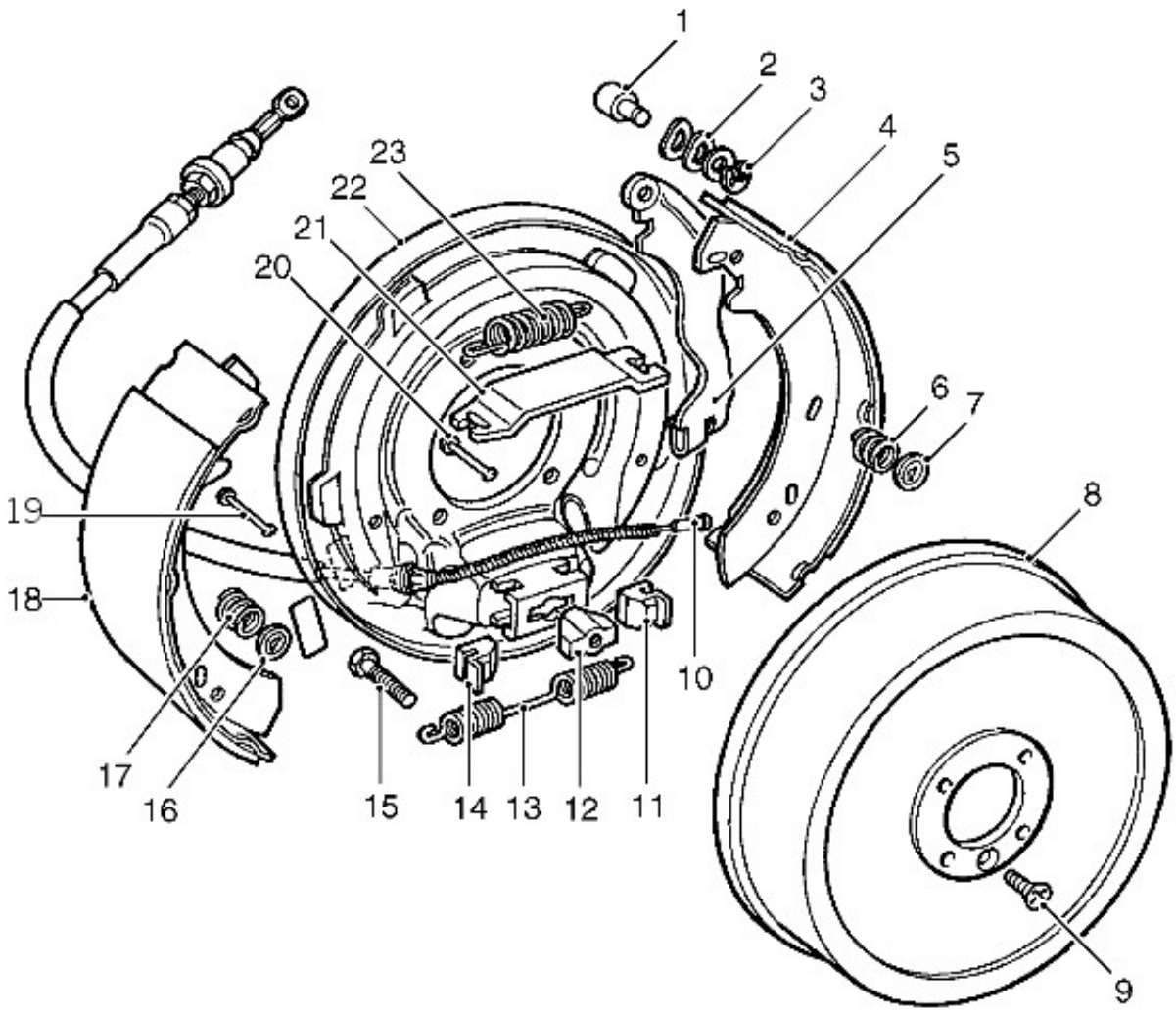
Modifications to the rear brakes have been introduced on 110 and 130 models. This is to increase the service life of the rear brake pads in harsh environments.

New rear brake calipers are introduced which allow the fitment of brake pads with a thicker friction material. The brake pads have increased leading and trailing edge chamfers which improve efficiency

Aerodynamic deflectors are located forward of the rear wheels to protect the rear calipers from the ingress of dirt, which can cause excessive pad wear. The deflectors are fitted to 90, 10 and 130 models in markets where environmental conditions can cause excessive brake pad wear.

Parking brake

Parking brake components



Item	Part Number	Description
1	-	Pin
2	-	Washer
3	-	'C' clip
4	-	Brake shoe
5	-	Cable lever
6	-	Hold down spring
7	-	Dished washer
8	-	Brake drum
9	-	Screw
10	-	Brake cable
11	-	Adjuster slide
12	-	Adjuster nut
13	-	Spring
14	-	Adjuster slide
15	-	Adjuster bolt
16	-	Dished washer
17	-	Hold down spring
18	-	Brake shoe
19	-	Hold down pin
20	-	Hold down pin
21	-	Abutment plate
22	-	Back plate
23	-	Spring

Brake System - General Information - Brake System Bleeding

General Procedures

WARNING: Do not allow brake fluid to come into contact with eyes or skin.

• CAUTIONS:

Brake fluid can damage paintwork, if spilled wash off immediately with plenty of clean water.

Use only correct grade of brake fluid. If an assembly fluid is required use ONLY brake fluid. Do NOT use mineral oil, i.e. engine oil etc.

Thoroughly clean all brake calipers, pipes and fittings before commencing work on any part of the brake system. Failure to do so could cause foreign matter to enter the system and cause damage to seals and pistons which will seriously impair the efficiency of the brake system. To ensure the brake system efficiency is not impaired the following warnings must be adhered to :-

- DO NOT use any petroleum based cleaning fluids or any proprietary fluids containing petrol.
- DO NOT use brake fluid previously bled from the system.
- DO NOT flush the brake system with any fluid other than the recommended brake fluid. The brake system should be drained and flushed at the recommended service intervals. Cover all electrical terminals carefully to make absolutely certain that no fluid enters the terminals and plugs.
- Cover all electrical terminals carefully to make absolutely certain that no fluid enters the terminals and plugs.
- During bleed procedure, brake fluid level must not be allowed to fall below the MIN mark. Keep reservoir topped up to the MAX mark.
- To bleed the hydraulic circuits, four bleed nipples are provided, one at each caliper.

1. There are two methods by which air can be removed from the braking system:

1. MANUAL BLEED PROCEDURE
2. PRESSURE BLEED PROCEDURE

2. Pressure bleed procedure

1. Purpose designed equipment for pressure filling and bleeding of hydraulic systems may be used on Land Rover vehicles . The equipment manufacturers instructions must be followed and the pressure must not exceed 4.5 bar, 65lb/in.

3. Manual bleed procedure Equipment required

1. Clean glass receptacle
2. Bleed hose
3. Wrench
4. Approx. 2 litres (3 pts) brake fluid

4. Master cylinder bleed

1. Disconnect battery negative lead
2. Depress brake pedal fully and slowly 5 times.
3. Release pedal and wait 10 seconds.
4. Repeat until firm resistance is felt at the pedal.

5. Complete circuit bleed

1. Disconnect battery negative lead
2. Fit bleed hose to caliper bleed screw.
3. Dip free end of bleed hose into brake fluid in bleed bottle.
4. Open bleed nipple.
5. Depress brake pedal fully several times until fluid is

clear of air bubbles.

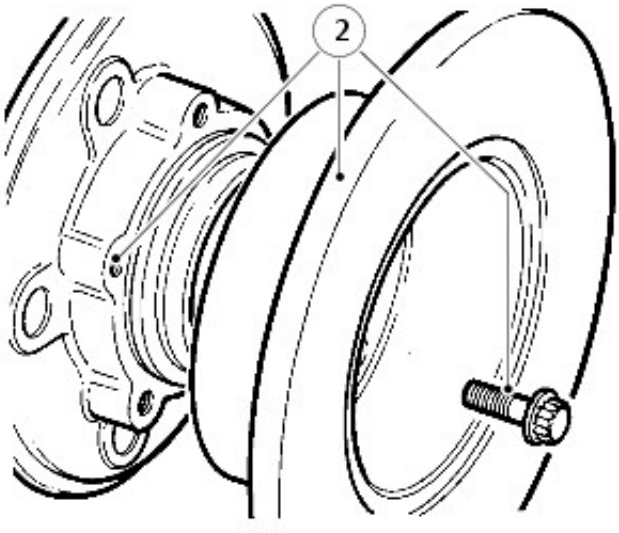
6. Keeping pedal fully depresses, tighten bleed nipple then release pedal.
7. Repeat procedure for remaining calipers.
8. Fit bleed screw protection caps.
9. Check/top-up fluid level when bleeding is complete.

Front Disc Brake - Brake Disc

Removal and Installation

Removal

1. Remove hub assembly.
   For additional information, refer to: Front Wheel Bearing and Wheel Hub (204-01 Front Suspension, Removal and Installation).
2. Remove 5 hub to disc bolts.



J5369M

3. NOTE: On 110/130 vehicles ventilated discs are fitted as standard.

   Tap disc to separate from hub.

Installation

1. Locate disc to hub.
2. Apply Loctite 270 to disc bolts and tighten to 73 Nm (54 lbf.ft).
3. Check total disc runout with a dial indicator, this must not exceed 0,15 mm, 0.006 in. If necessary reposition disc.
4. Instal hub assembly.
   For additional information, refer to: Front Wheel Bearing and Wheel Hub (204-01 Front Suspension, Removal and Installation).
5. Disc reclamation
6. NOTE: The disc MUST BE renewed if the minimum running thickness stamped on the disc is recorded.

   Check disc thickness. This dimension may be machined to minimum thickness of 12 mm (0.47 in.) - solid discs, 22 mm (0.90 in) - ventilated discs. Machine equal amount off each face.

Front Disc Brake - Brake Pads

Removal and Installation

Removal

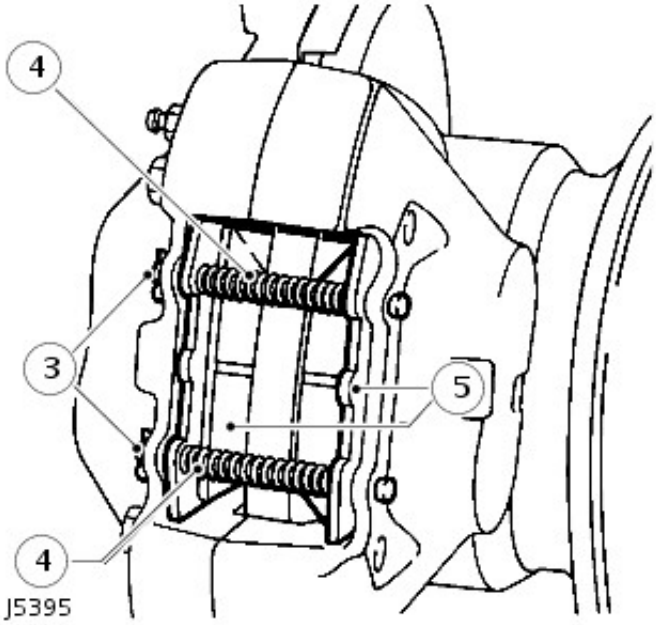
1. Remove front road wheels.

2. Clean exterior of calipers.

3. Remove split pin from retaining pins.

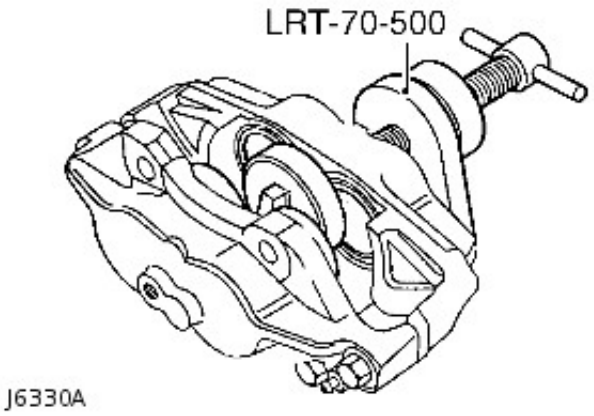
4. Remove pad retaining pins and anti-rattle springs.

5. Remove brake pads.



6. Clean exposed parts of pistons, using new brake fluid. Wipe away excess with a lint free cloth.

7. Using piston clamp LRT-70-500 press each piston back into its bore. Ensure that displaced brake fluid does not overflow from reservoir.



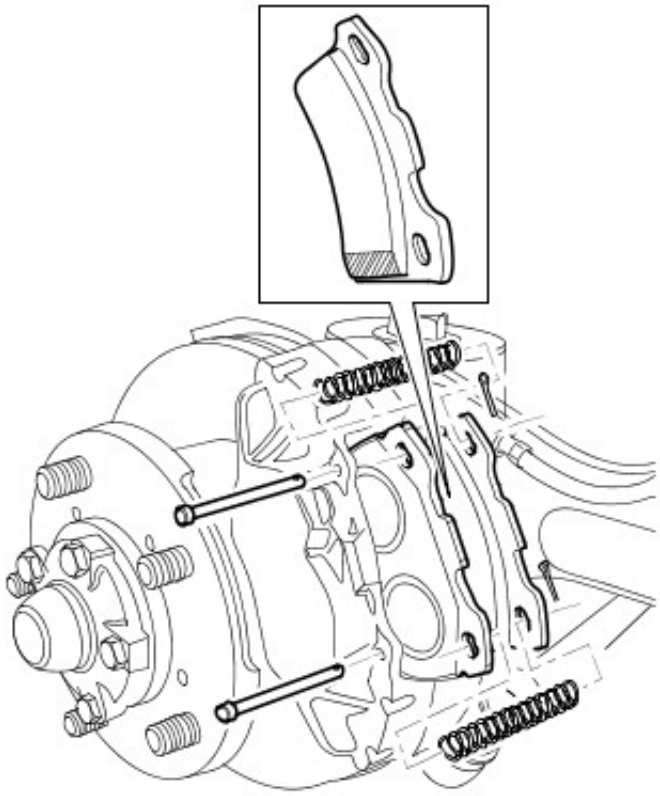
Installation

1. Instal brake pads.

• NOTE: Ensure pads are correctly fitted, with leading edge chamfer fitted as shown.

2. Instal pad retaining pins and anti-rattle springs. Secure

with new split pins.



M701113

3. Apply brake pedal several times to locate pads.
4. Instal road wheels, remove chassis stands and jack. Tighten wheel nuts to 130 Nm (96 lbf.ft).
5. Check fluid reservoir. Top up if necessary, using correct grade of fluid.
   For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).

Front Disc Brake - Brake Caliper

Removal and Installation

Removal

1. Loosen front road wheel nuts.

2. WARNING: Support on safety stands.

Raise front of vehicle.

3. Remove road wheel.

4. Remove split pins from pad retaining pins.

5. Remove brake pad retainers and springs.

6. Remove brake pads and shim if fitted.

7. Pull back brake hose shield.

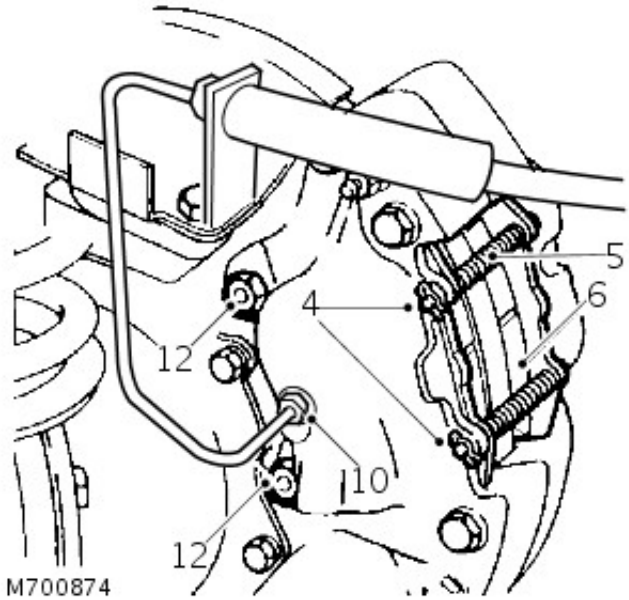
8. Clamp brake hose using a suitable clamp.

9. Position container beneath brake caliper to collect spillage.

10. Loosen brake pipe union and disconnect from caliper.

11. Plug brake pipe and caliper connections.

12. Remove 2 bolts securing caliper.

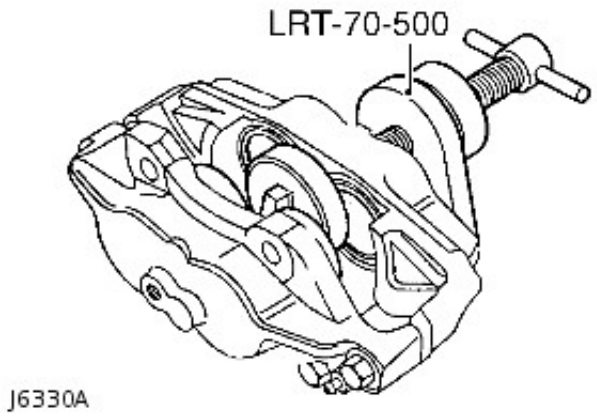


13. Remove brake caliper.

WARNING: Do not separate caliper halves

14. Clean outer surfaces of caliper using aerosol brake cleaner.

15. Using special tool LRT-70-500, clamp pistons in inboard half of caliper. Gently, keeping fingers clear, and with CAUTION , apply air pressure to fluid inlet port to expel pistons. It is unlikely that pistons will expel at same time, regulate rate with a suitable piece of wood between appropriate piston and caliper.



16. Finally remove pistons, identifying them with their respective bores.

17. Remove wiper seal retainer by inserting a blunt screwdriver between retainer and seal. Pry retainer carefully from mouth of bore.

18. Taking care not to damage seal grooves, extract wiper seal and fluid seal.

19. Clean bores, pistons and seal grooves using clean brake fluid only. If caliper or pistons are corroded, or their condition is not perfect, new parts must be fitted.

20. Coat new fluid seal with brake fluid. Ease seal into groove in bore using only fingers, ensuring it is properly seated. Fluid seal and groove are not same in section, so when seal is seated it feels raised to touch at edge furthest away from mouth of bore.

21. Coat appropriate piston with brake fluid. Insert it squarely into bore by hand only. Do not tilt piston during insertion, leave approximately 8mm projecting from bore.

22. Coat new wiper seal with brake fluid and fit to new seal retainer. Slide assembly, seal first, over protruding piston and into bore recess. Use piston clamp to press home seal retainer and piston.

23. Clamp outboard pistons and carry out same procedure for removing and fitting outboard pistons and seals.

Installation

1. Clean caliper to hub mating faces.

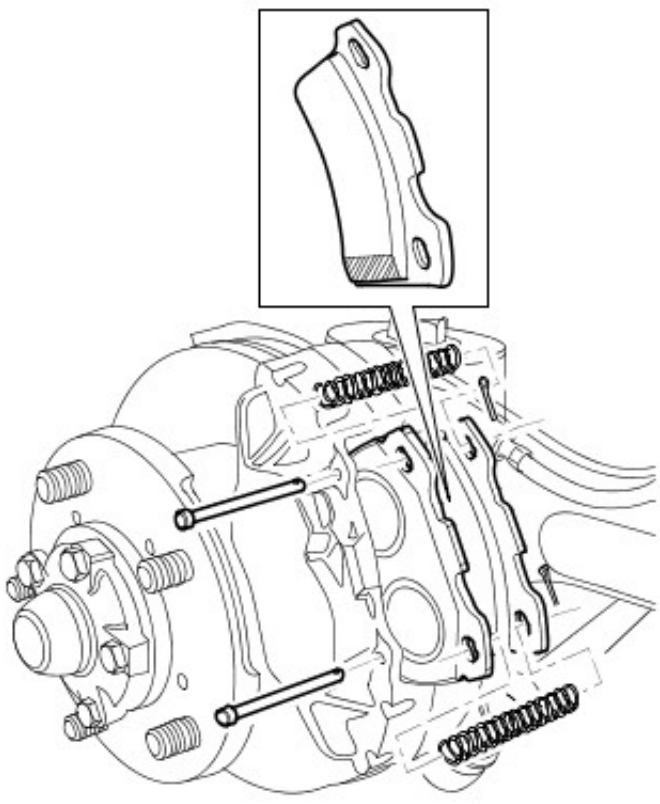
2. Position caliper to hub, install bolts and tighten to 82 Nm (60 lbf.ft).

3. Remove plugs from pipe to caliper connections and wipe.

4. Connect pipe to caliper, tighten union to 15 Nm (11 lbf.ft).

5. Apply a light film of grease to rear of brake pads.

6. Install pads to calipers. From 02MY, ensure pads are correctly fitted, with leading edge chamfer fitted as shown.



M701113

7. Install pad retainers and springs.

8. Install split pins to retainers.

9. Remove brake hose clamp.

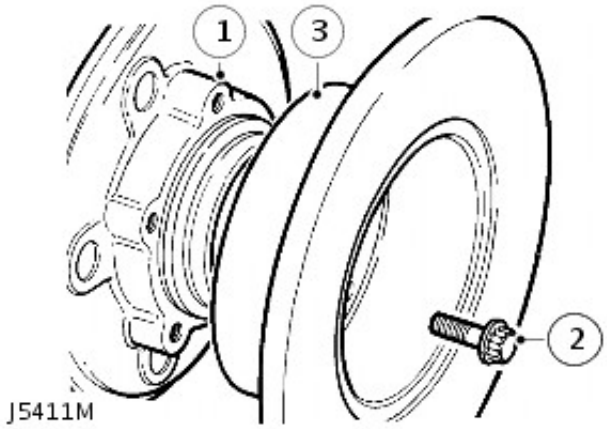
10. Bleed brakes.
For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

11. Depress brake pedal to seat pads onto discs.

12. Install road wheels, remove axle stands and tighten nuts to 130 Nm (96 lbf.ft).

Rear Disc Brake - Brake Disc

Removal and Installation



Removal

1. Remove rear wheel bearing and hub assembly.
   For additional information, refer to: Wheel Bearing and Wheel Hub (204-02 Rear Suspension, Removal and Installation).
2. Remove disc bolts.
3. Remove disc from rear hub.

Installation

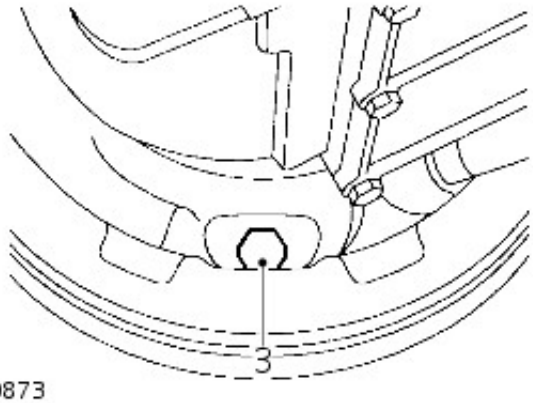
1. Install disc to rear hub.
2. Install disc bolts. Tighten to 73 Nm (54 lbf.ft).
3. Check total disc run out, this must not exceed 0,15 mm (0.006 in). If necessary reposition disc.
4. Install rear wheel bearing and hub assembly.
   For additional information, refer to: Wheel Bearing and Wheel Hub (204-02 Rear Suspension, Removal and Installation).
5. Disc reclamation.
6. NOTE: The brake disc MUST BE renewed if the minimum running thickness stamped on the disc is recorded.

   Check disc thickness. This dimension may be machined to minimum thickness of 12 mm. Machine equal amounts off each face.

Parking Brake and Actuation - Parking Brake Shoe and Lining Adjustment

General Procedures

• NOTE: The parking brake should be fully operational on third notch of ratchet.



M700873

1. Raise one rear wheel clear of ground and support on axle stand.

2. Release parking brake lever.

3. Tighten brake adjuster to 25 Nm (18 lbf.ft) to fully expand shoes to drum.

4. Back off adjuster 1½ turns, check that drum is free to rotate.

5. CAUTION: Cable adjustment must ONLY be used for initial setting and to compensate for cable stretch. It MUST NOT be used to take up brake shoe wear, which MUST be adjusted at brake drum.

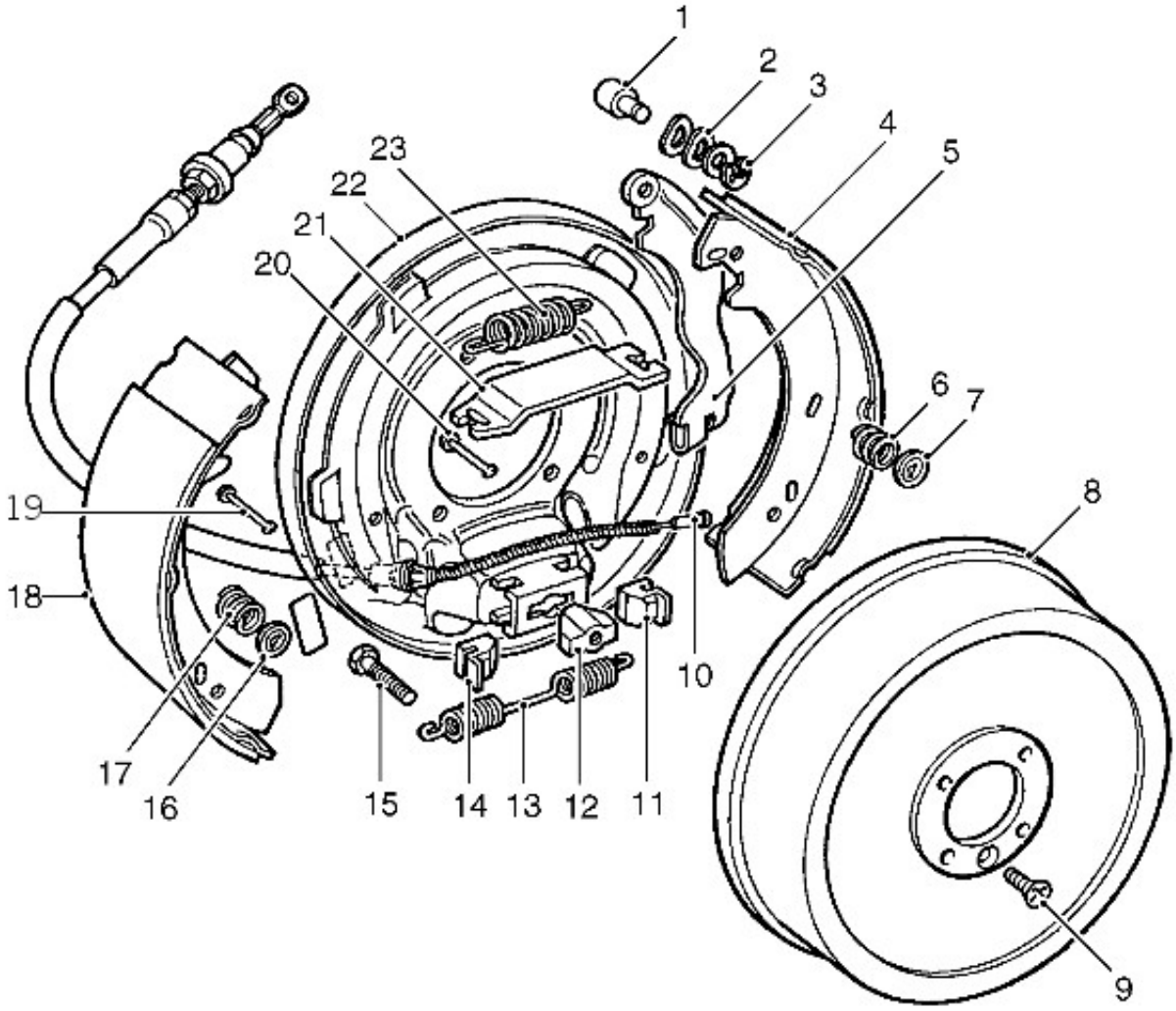
Check operation of parking brake lever to give pawl 2 notches free movement on ratchet before being fully operational on third notch of ratchet. Adjust parking brake accordingly if lever travel exceeds the above tolerance.

6. Remove axle stand and wheel chock.

Parking Brake and Actuation - Parking Brake Cable

Removal and Installation

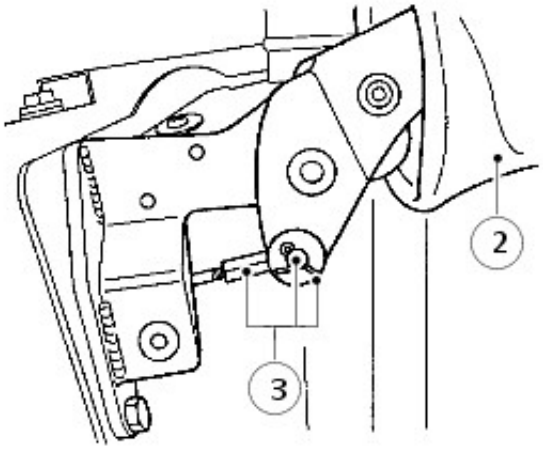
Removal



Item	Part Number	Description
1	-	Pin
2	-	Washer
3	-	'C' Circlip
4	-	Brake shoe
5	-	Cable lever
6	-	Hold down spring
7	-	Dished washer
8	-	Brake drum
9	-	Screw
10	-	Brake cable
11	-	Adjuster slide
12	-	Adjuster nut
13	-	Spring
14	-	Adjuster slide
15	-	Adjuster bolt
16	-	Dished washer
17	-	Hold down spring
18	-	Brake shoe
19	-	Hold down pin
20	-	Hold down pin
21	-	Abutment plate
22	-	Back plate
23	-	Spring

1. Park vehicle on level ground, chock road wheels and release parking brake. Alternatively, raise vehicle on ramp.

2. Remove 3 trim studs and lift up parking brake gaiter.



J6338

3. Remove split pin, clevis pin, washer and disconnect cable from parking brake lever.

4. Slacken off transmission brake drum adjusting screw.

5. Disconnect drive shaft from output flange.

6. Remove retaining screw and withdraw brake drum.

7. Release parking brake cable clevis from abutment on cable lever, see J6337, and pull through aperture in back plate.

8. Pull cable from heelboard and remove from vehicle.

Installation

1. Feed new cable through heelboard ensuring rubber grommet is correctly located.

2. Position cable over guide plate, insert through backplate and connect to cable lever.

3. Instal cable to parking brake lever and secure with clevis pin and split pin.

4. Instal parking brake gaiter.

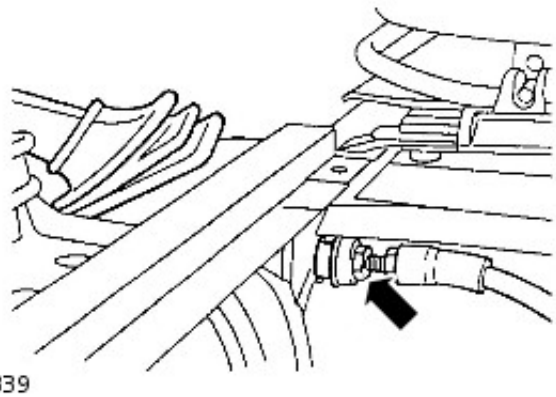
5. Instal brake drum. Tighten screw to 25 Nm (18 lbf.ft).

6. Screw in and tighten adjuster bolt until brake drum will not rotate by hand.

7. Tighten adjuster bolt further to 25 Nm (18 lbf.ft) to ensure brake drum is locked.

8. Slacken off adjuster bolt by 1.5 turns to give brake shoes running clearance. Check that the drum is free to rotate.

9. Slacken locknut and adjust cable to give the parking brake pawl two notches free movement on the rachet before being fully operational on third notch (brake shoes are fully expanded against drum).



J6339

• NOTE: Cable adjustment is for a new cable or to compensate for cable stretch. Cable adjustment must not be used to take up brake shoe wear.

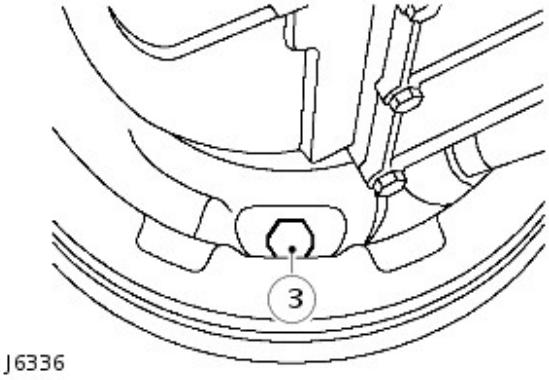
10. Instal drive shaft to output flange. Tighten fixings to 46 Nm (34 lbf.ft).

11. Remove wheel chocks and check operation of parking brake.

Parking Brake and Actuation - Shoes

Removal and Installation

Removal



J6336

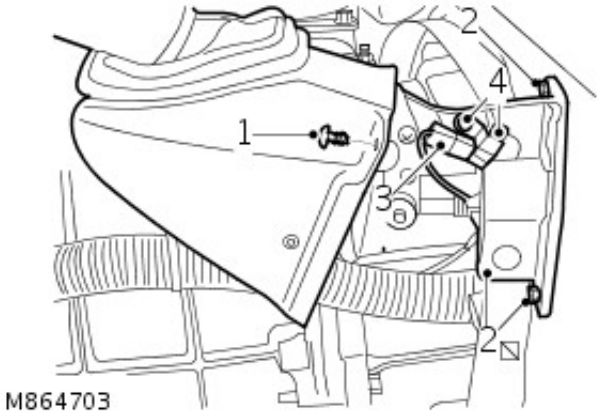
1. Park vehicle on level ground, chock road wheels and release parking brake. Alternatively, raise vehicle on a ramp.
2. Disconnect rear propeller shaft from transmission output flange at brake drum.
3. Slacken off parking brake drum adjustment bolt.
4. Remove single screw securing brake drum to output flange.
5. Withdraw drum to expose brake assembly.
6. Release top and bottom springs from brake shoes, see J6337.
   For additional information, refer to: Parking Brake Cable (206-05 Parking Brake and Actuation, Removal and Installation).
7. Grip dished washer with a pair of pliers, depress washer and turn through 90°.
8. Remove dished washer, complete with hold down spring and pin from both shoes.
9. Move brake shoes out from adjuster slides, release from abutment plate and remove from backplate.
10. Check that springs are satisfactory for continued use. If new brake shoes are to be fitted, the springs should also be renewed.

Installation

1. Locate RH brake shoe in slide and secure brake shoe and lever assembly to backplate with hold down pin, spring and dished washer.
2. Locate LH brake shoe in slide and fit abutment plate between both brake shoes. Secure LH shoe with hold down pin, spring and dished washer.
3. Instal pull-off springs to brake shoes.
4. Instal brake drum. Tighten screw to 25 Nm (18 lbf.ft).
5. Check that hand brake lever is released.
6. Screw in and tighten adjuster bolt until brake drum will not rotate by hand.
7. Tighten adjuster bolt to 25 Nm (18 lbf.ft) to ensure brake drum is locked.
8. Slacken off adjuster bolt by 1.5 turns to give shoes a running clearance. Check that the drum is free to rotate.
9. Instal propeller shaft to output flange. Tighten fixings to 46 Nm (34 lbf.ft).
10. Remove wheel chocks and check operation of parking brake.

Parking Brake and Actuation - Parking Brake Switch

Removal and Installation



Removal

1. Release cover from parking brake lever.
2. Remove 2 bolts and release parking brake lever from body.
3. Release connector from parking brake switch.
4. Remove 2 screws securing parking brake switch to parking brake lever and remove switch.

Installation

1. Install parking brake switch to parking brake lever and tighten screws.
2. Install connector to parking brake switch.
3. Position parking brake lever and tighten bolts to 22 Nm (16 lbf.ft).
4. Position cover to parking brake lever.

Hydraulic Brake Actuation - Brake Master Cylinder

Removal and Installation

Removal

1. Disconnect battery negative lead.

2. CAUTION: Do not allow brake fluid to contact paint finished surfaces as paint may be damaged. If spilled, remove fluid and clean are with clean warm water.

Place a container under the master cylinder to collect any brake fluid spillage.

3. Clean area around master cylinder ports.

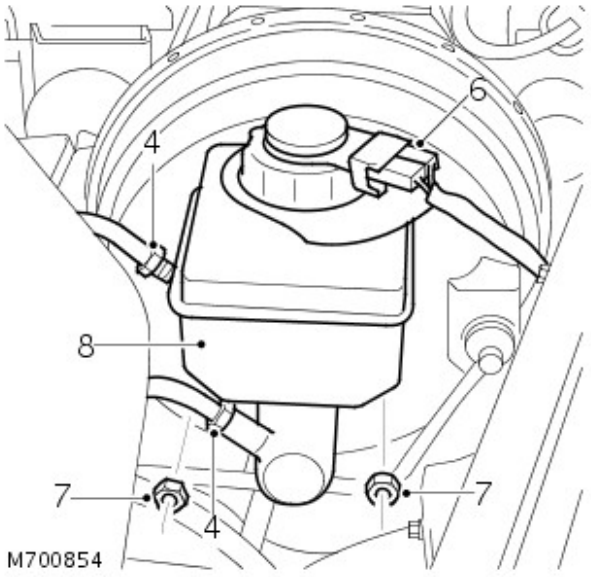
4. Loosen 2 unions securing brake pipes to master cylinder ports.

5. Disconnect both brake pipes from master cylinder. Cover, not plug, pipe ends to prevent entry of dirt.

6. Release 2 connectors from reservoir cap.

7. Remove 2 nuts securing master cylinder to brake booster.

8. Withdraw master cylinder from booster and remove.



9. Carefully ease reservoir from master cylinder by rolling it from seals.

10. NOTE: Master cylinder to reservoir seals are different sizes.

Remove seals from master cylinder.

Installation

1. Instal NEW seals to master cylinder, ensuring seals are fitted to correct ports.

2. Instal reservoir to master cylinder.

3. Ensuring that water ingress seal is in position, instal master cylinder to booster.

4. Instal nuts securing master cylinder to booster and tighten to 26 Nm (19 lbf.ft).

5. Connect brake pipes to master cylinder and tighten unions to 15 Nm (11 lbf.ft).

6. Instal connectors to reservoir cap.

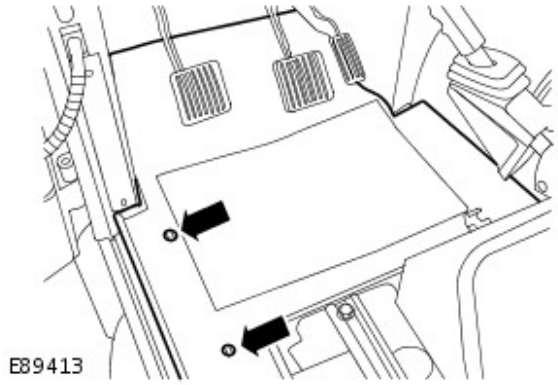
7. Fill reservoir with recommended brake fluid.
For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).

8. Bleed the brake system.
For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

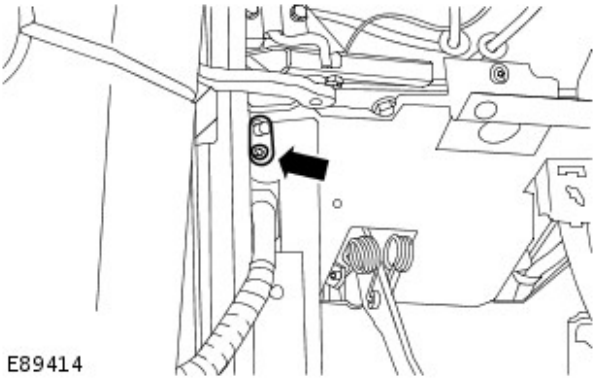
Hydraulic Brake Actuation - Brake Pedal and Bracket
Removal and Installation

Removal

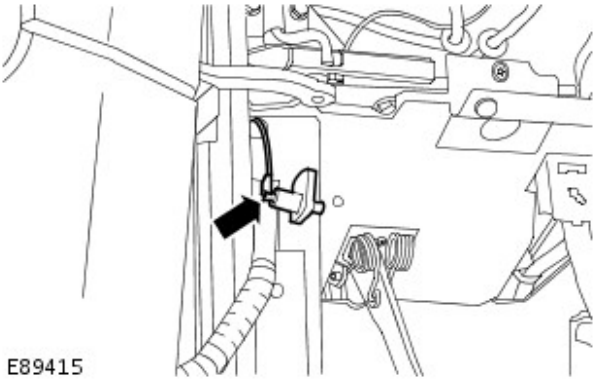
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the brake booster.
   For additional information, refer to: Brake Booster (206-07 Power Brake Actuation, Removal and Installation).
3. Remove the stoplamp switches.
   For additional information, refer to: Stoplamp Switch (417-01 Exterior Lighting, Removal and Installation).
4. Remove the floor covering.
   - Remove the 2 clips.



5. Release the interior lamp switch.
   - Remove the screw.

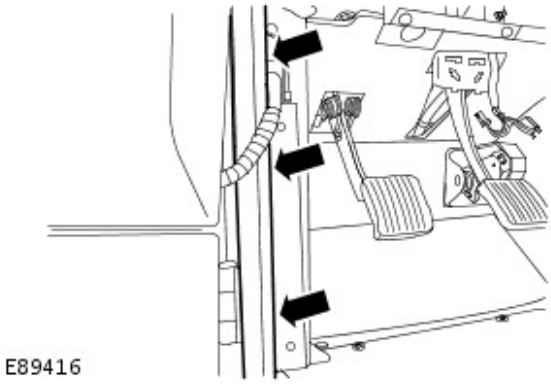


6. Remove the interior lamp switch.
   - Disconnect the electrical connector.



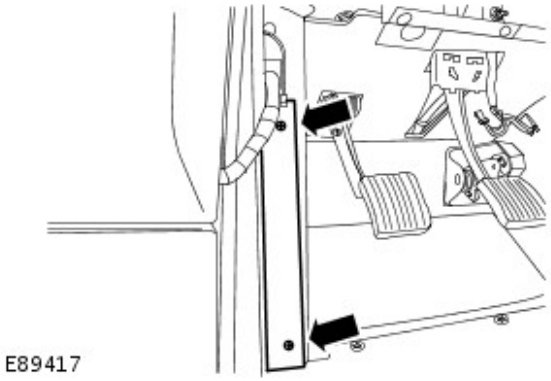
7. Release the front door aperture seal.

7. Release the front door aperture seal.

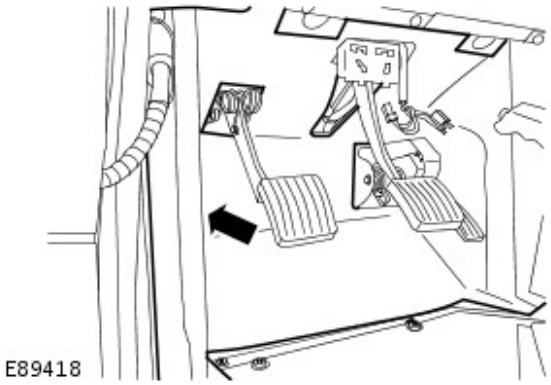


8. Remove the A-pillar trim panel.

- Remove the 2 screws.

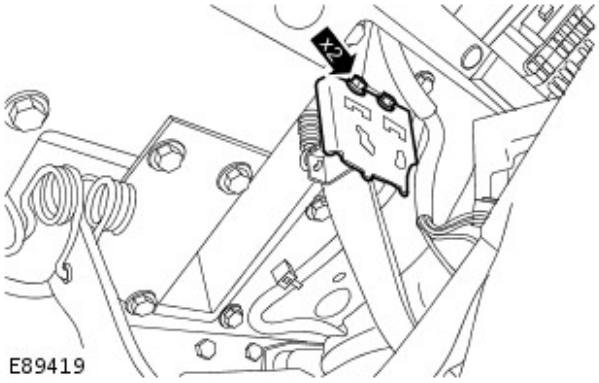


9. Release the floor covering away from the bulkhead.

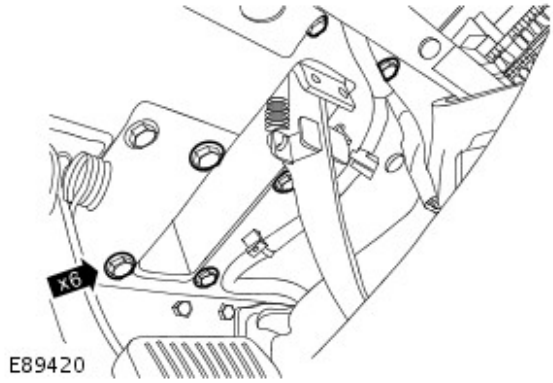


10. Remove the stoplamp switch support bracket.

- Remove the 2 bolts.

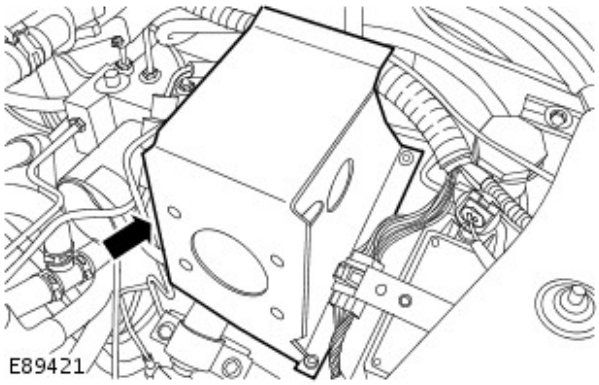


11. Release the brake pedal and bracket.



- Remove the 6 bolts.

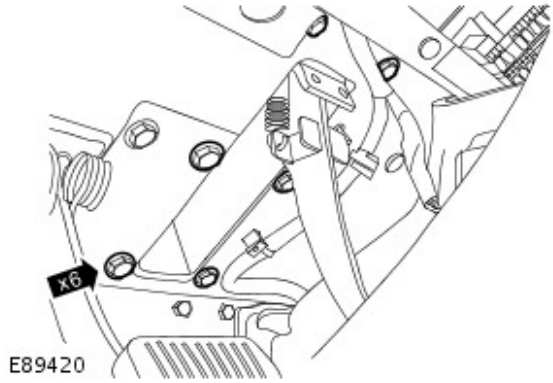
12. Remove the brake pedal and bracket.



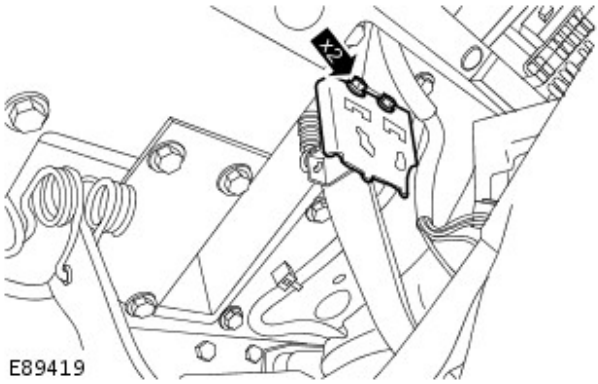
Installation

1. To install, reverse the removal procedure.

- Tighten to 25 Nm (18 lb.ft).



2. Tighten to 9 Nm (7 lb.ft).



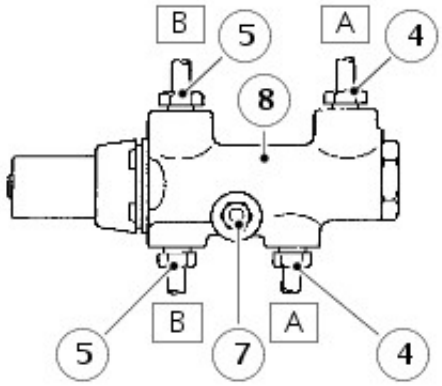
3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Hydraulic Brake Actuation - Brake Pressure Control Valve

Removal and Installation

Removal

1. Disconnect battery.
2. Clean area around brake pressure control valve ports.
3. Place a container under valve to catch escaping brake fluid.
4. Disconnect primary circuit pipe unions 'A' from brake pressure control valve.
5. Disconnect secondary circuit pipe unions 'B' from brake pressure control valve.
6. Cover pipes to prevent ingress of dirt.
7. Remove single retaining nut and bolt securing brake pressure control valve to engine bulkhead.
8. Remove brake pressure control valve.



J6340

Installation

1. Fit brake pressure control valve to engine bulkhead. Tighten bolt to 15 Nm (11 lbf/ft).
2. Connect primary and secondary circuit pipes to brake pressure control valve. Tighten unions to 16 Nm (12 lbf/ft).
3. Fill brake reservoir with recommended brake fluid.
   For additional information, refer to: Specifications (206-00 Brake System - General Information, Specifications).
4. Bleed the brake system.
   For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
5. Reconnect battery and road test vehicle.

Hydraulic Brake Actuation - Brake Master Cylinder

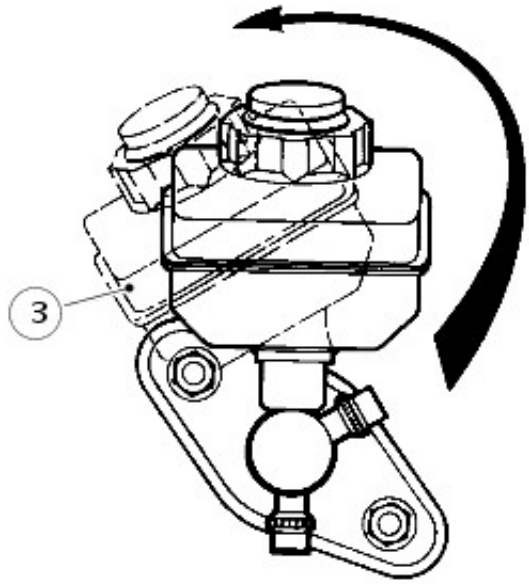
Disassembly and Assembly

Disassembly

1. Disconnect battery and remove master cylinder from booster. For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Before commencing overhaul procedure thoroughly clean master cylinder and inspect outer surfaces for damage and condition, renew complete assembly if necessary.

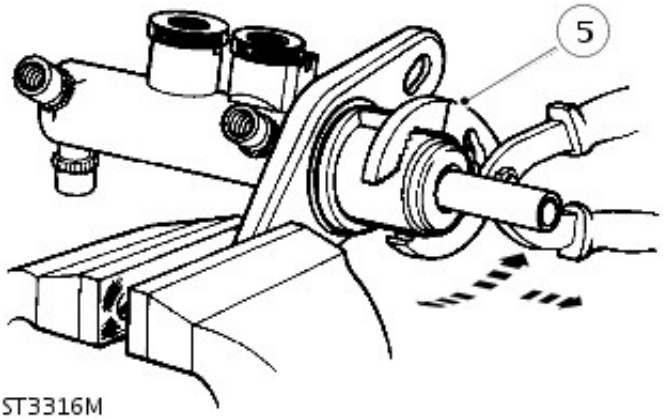
3. The reservoir is a push fit in master cylinder and secured by seals. Carefully ease reservoir from master cylinder by rolling it from seals as illustrated.



ST3317M

4. Using soft jaws, one either side of master cylinder flange and clamp flange in a suitable vice. Remove water ingress O-ring seal from master cylinder to booster flange and discard.

5. Hold outside of transfer housing with a suitable pair of grips, carefully pull, while working pliers in a backwards and forwards rocking motion to ease housing off master cylinder, discard housing and vacuum seal.

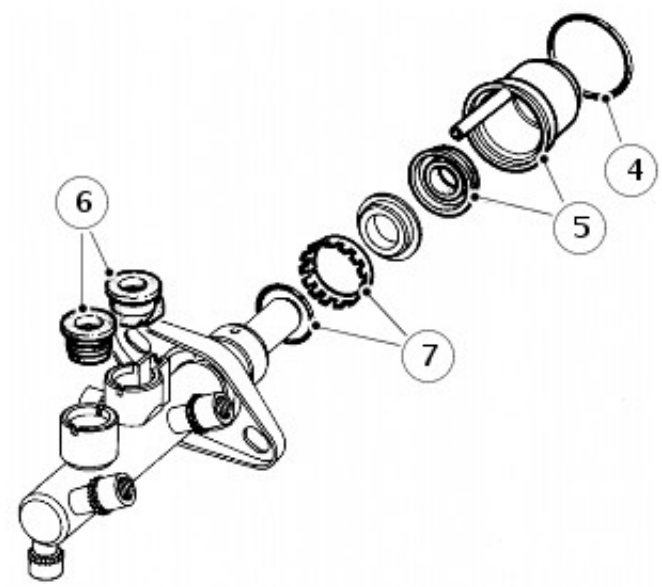


ST3316M

6. Withdraw 2 reservoir seals from master cylinder and note their positions in inlet ports for reassembly. Discard both seals.

7. Remove retaining ring and O-ring seal from machined

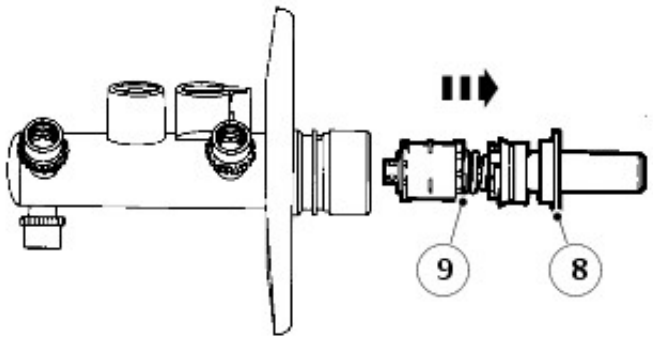
outer surface of master cylinder, discard both seal and retaining ring.



ST3318M

8. Remove guide ring from mouth of master cylinder which supports primary plunger assembly and place to one side, this component is not part of master cylinder service kit and is to be refitted on assembly of unit.

9. Pull primary plunger assembly out of master cylinder.



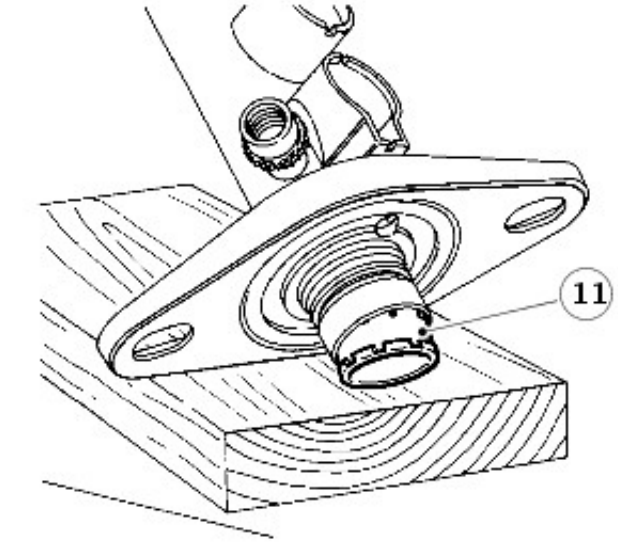
ST3319M

• NOTE: The primary plunger assembly cannot be broken down any further and is serviced as a complete unit. Discard assembly.

10. The secondary plunger assembly will remain at bottom of master cylinder bore, plunger can be easily expelled by tapping assembly on a piece of timber until plunger appears at cylinder mouth, carefully pull plunger from master cylinder.

11. If swirl tube was not expelled at same time as secondary

plunger, repeat above operation to expel it from bottom of master cylinder bore and discard.

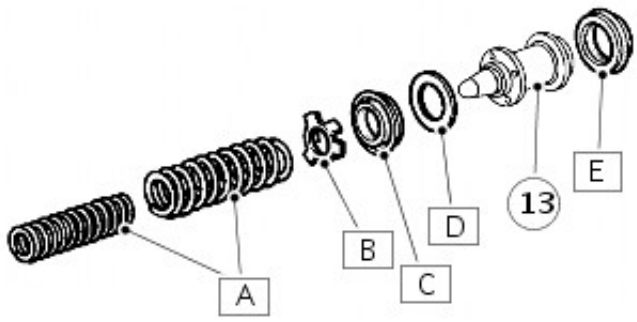


ST3320M

12. Clean all parts with Gilling cleaning fluid or unused brake fluid and place cleaned parts on to a clean sheet of paper. Inspect cylinder bore and plungers for signs of corrosion, ridges and score marks. Provided working surfaces are in perfect condition, new seals from a Gilling Service repair kit may be used.

13. Remove components above from secondary plunger and discard:

Item	Part Number	Description
A	-	Springs
B	-	Seal retainer
C	-	Recuperating seal (primary cup)
D	-	Washer
E	-	'L' seal

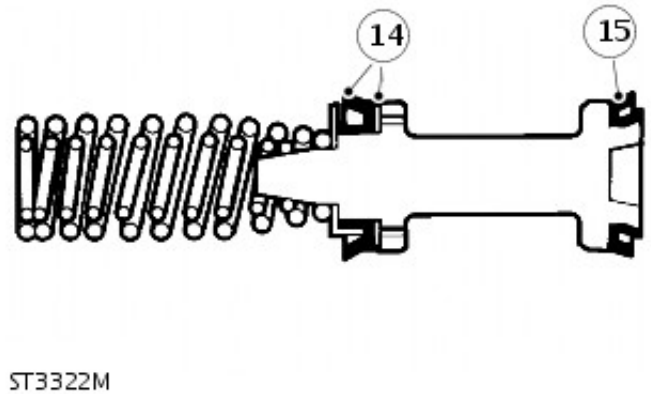


ST3321M

• NOTE: A small screwdriver with end rounded and polished is required to remove 'L' seal. DO NOT damage secondary plunger.

14. Coat new seals in unused brake fluid and firstly install 'L' seal to plunger.

15. Install washer followed by recuperating seal. Install seal retainer and springs, ensure springs are correctly seated.



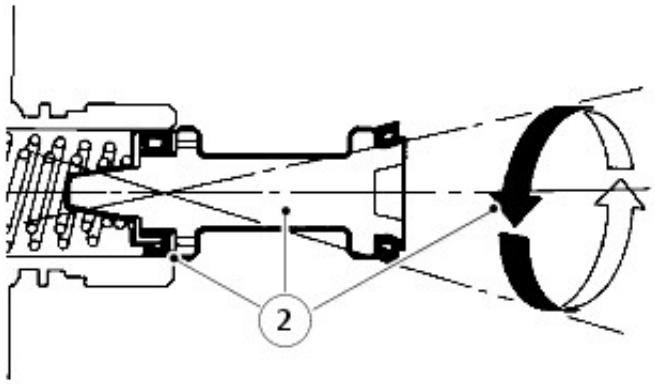
ST3322M

Assembly

⚠ CAUTION: It is important that the following instructions are carried out precisely, otherwise damage could be

caused to new seals when inserting plungers into cylinder bore. Generous amounts of new brake fluid should be used to lubricate parts during assembly.

• NOTE: Thoroughly check that no debris is lodged in fluid passageways and drillings. If debris is found, carefully remove, re-clean cylinder and re-check.



ST3323M

1. Install new swirl tube to bottom of cylinder bore.

2. Lubricate secondary plunger and cylinder bore. Offer plunger assembly to cylinder until recuperation seal is resting centrally in mouth of bore. Gently introduce plunger with a circular rocking motion, as illustrated. Ensuring that seal does not become trapped, ease seal into bore and slowly push plunger down bore in one continuous movement.

3. Install primary plunger assembly using same method as for secondary plunger, push plunger down bore.

4. Install original guide ring to support primary plunger.

5. Coat a new O-ring with brake fluid and install to its respective groove on outer location surface of master cylinder.

CAUTION: O-ring should not be rolled down outer location surface of master cylinder but should be slightly stretched and eased down cylinder and into its groove. Do not over stretch seal.

6. Install a new retaining ring on outer surface of master cylinder ensuring that serrations of ring are facing mounting flange.

7. Install two new reservoir seals in their respective ports.

8. Install a new vacuum seal to either primary plunger or to bottom of transfer housing bore, open face of seal towards primary plunger guide ring.

9. Lubricate vacuum seal with brake fluid, install transfer housing to master cylinder, push housing fully up to cylinder mounting flange. Do not adjust transfer housing after fitting.

10. Lubricate a new water ingress seal with brake fluid, slightly stretch seal and ease it down housing until seal is in correct position between housing and flange.

11. Roll reservoir into top of master cylinder, reversing procedure described in instruction 3.

12. Install master cylinder to booster.
For additional information, refer to: Brake Master Cylinder (206-06 Hydraulic Brake Actuation, Removal and Installation).

13. Reconnect battery, and road test vehicle.

Power Brake Actuation -

Description	Nm	lb-ft
Brake vacuum pump bolts	23	17
Brake booster nuts	14	10
Brake master cylinder nuts	26	19

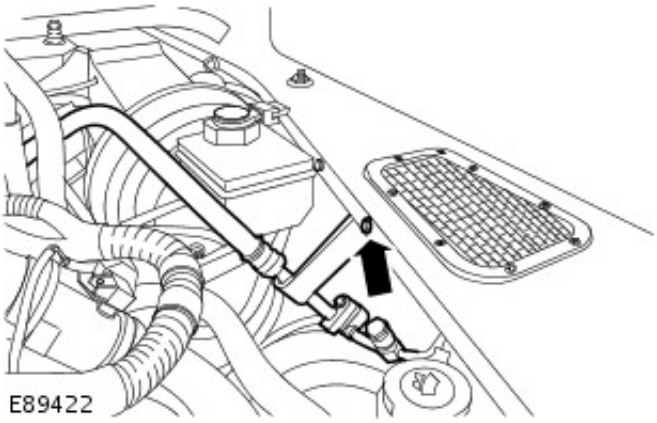
Power Brake Actuation - Brake Booster
Removal and Installation

Removal

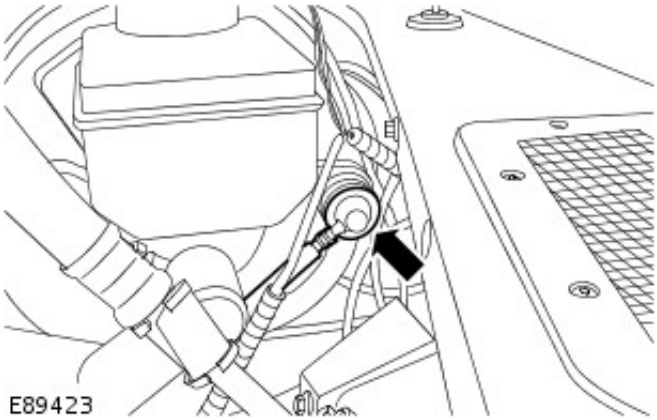
1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Release the air conditioning (A/C) high-pressure pipe.

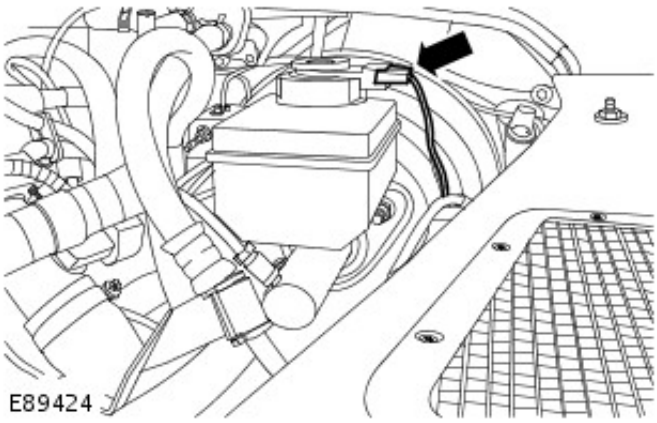
- Remove the bolt.



3. Release the brake booster vacuum hose.

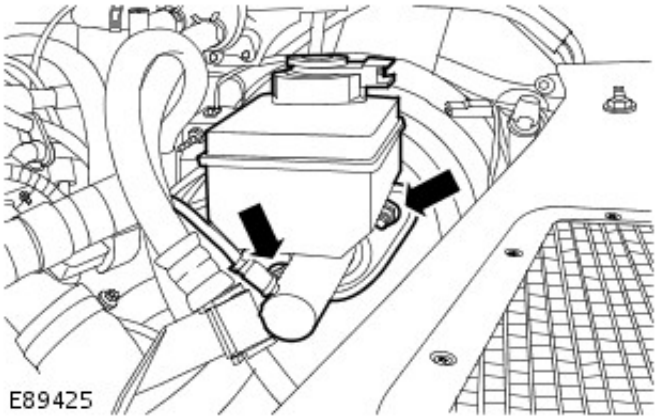


4. Disconnect the 2 electrical connectors from the brake fluid low level warning indicator.



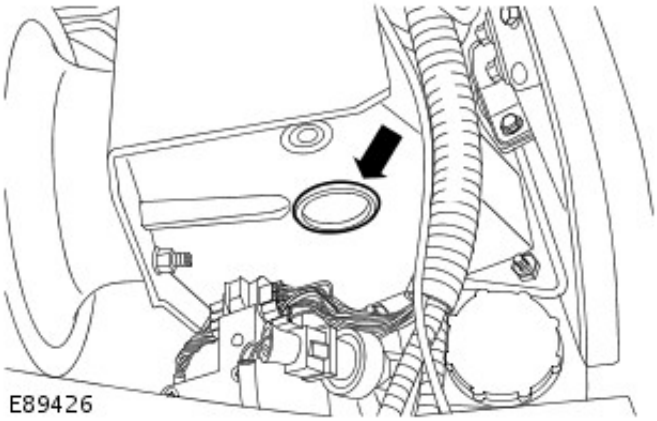
5. Release the brake master cylinder.

- Remove the 2 nuts.


E89425

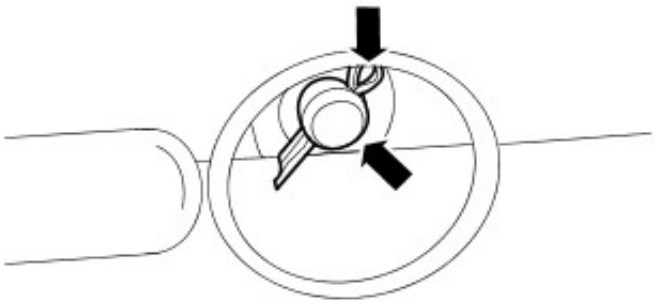
6. NOTE: RH shown, LH similar.

Remove the 2 grommets from the brake pedal box.


E89426

7. Remove the brake booster clevis pin.

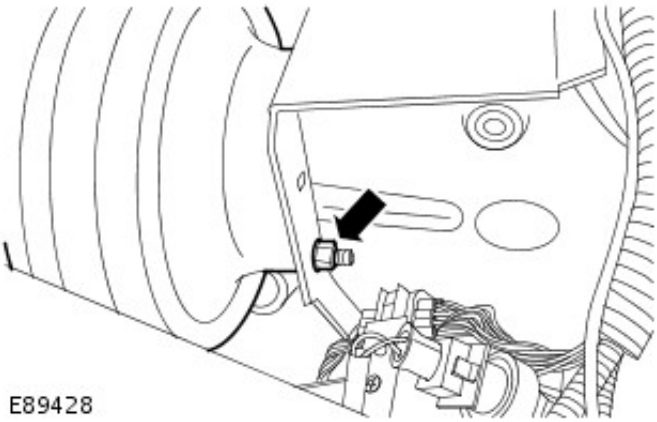
- Remove and discard the split pin.


E89427

8. NOTE: RH shown, LH similar.

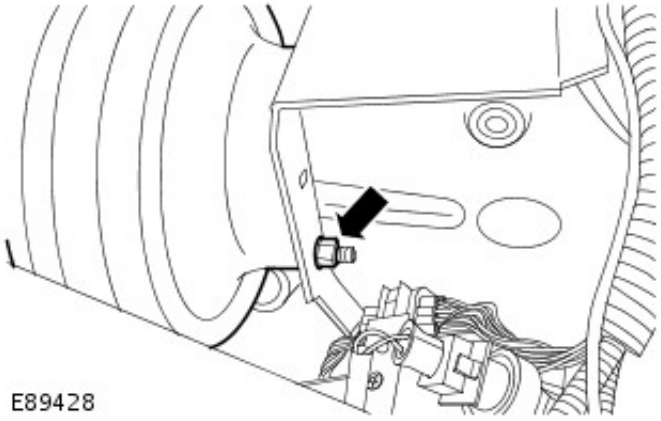
Remove the brake booster.

- Remove the 2 nuts.

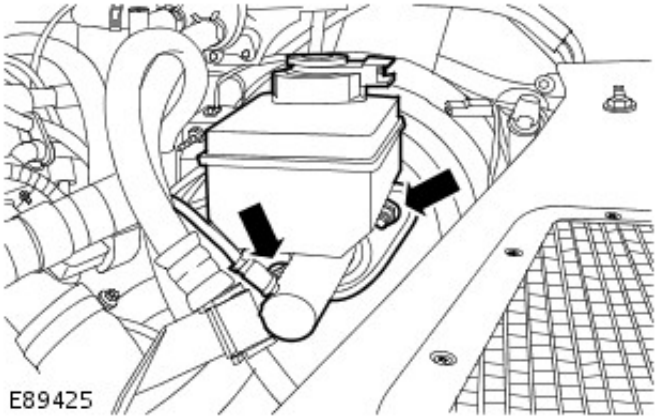

E89428

Installation

1. To install, reverse the removal procedure.



- Tighten to 14 Nm (10 lb.ft).



2. Tighten to 26 Nm (19 lb.ft).

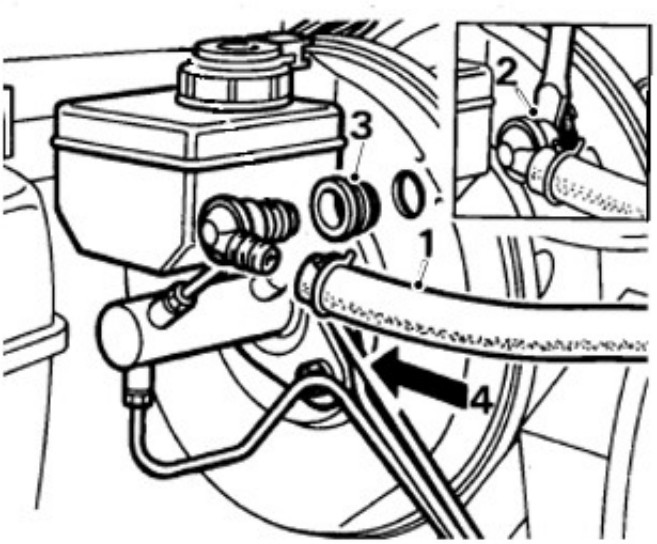
3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Power Brake Actuation - Brake Booster Non-Return Valve

Removal and Installation

Removal

1. Disconnect brake vacuum hose from booster non return valve.
2. Carefully prise valve out with a screwdriver blade between valve and grommet. Take care not to exert too much pressure on the vacuum chamber.
3. Remove rubber grommet but be careful not to allow it to fall into the vacuum chamber.
4. Check the valve for correct operation; it should not be possible to pass air through into the booster in direction of arrow. Do not use compressed air.



E82218

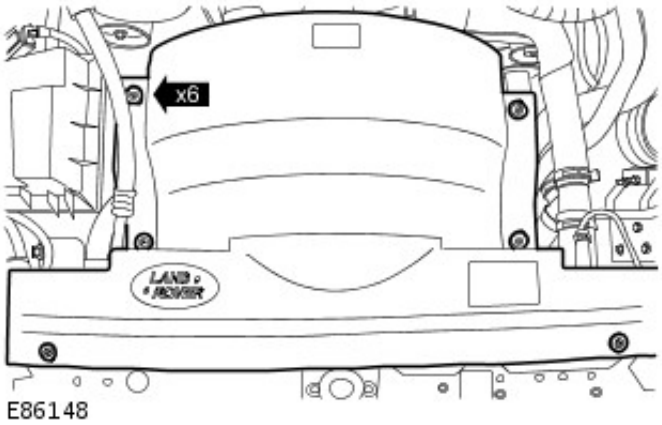
Installation

1. Install rubber grommet.
2. Smear ribs of the valve with Lucas Girling rubber grease to assist assembly, and push valve fully home.
3. Connect vacuum hose to the valve.
4. Road test vehicle.

Power Brake Actuation - Brake Vacuum Pump

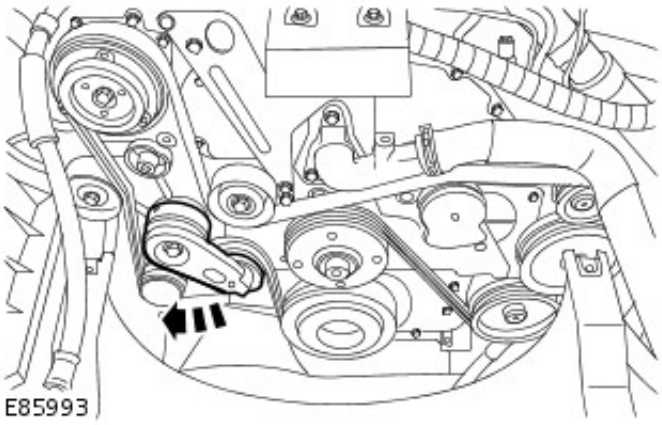
Removal and Installation

Removal



1. Remove the cooling fan upper shroud.

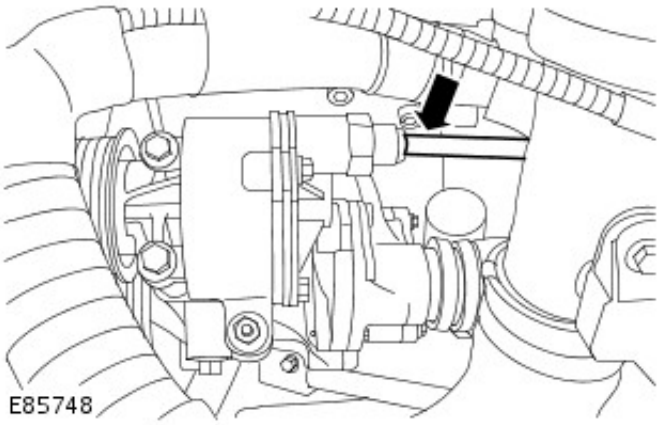
- Release the 6 screws.



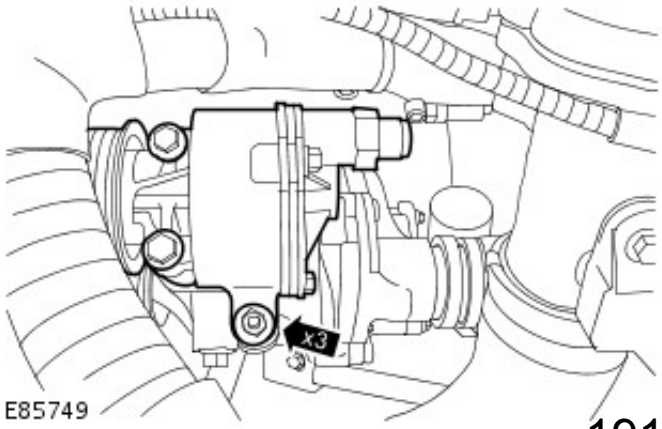
2. NOTE: Cooling fan shown removed for clarity.

Release the tension from the accessory drive belt.

- Rotate the accessory drive belt tensioner clockwise.
- Displace the accessory drive belt from the brake vacuum pump pully.



3. Disconnect the brake vacuum pump vacuum pipe.



4. CAUTIONS:

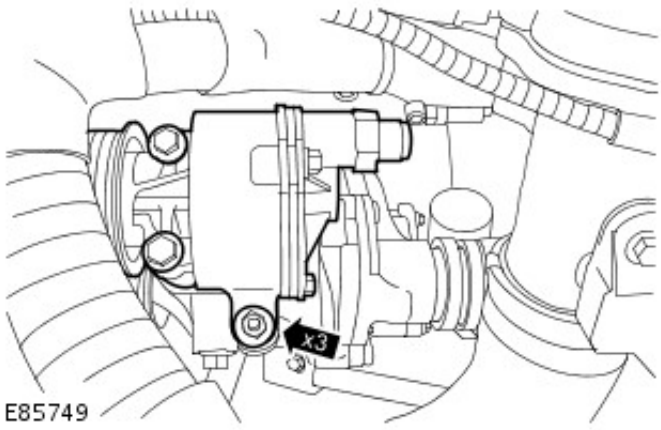
⚠ Make sure that all openings are sealed. Use new blanking caps.

⚠ Note position of fixing bolts for installation.

Remove the brake vacuum pump.

- Remove the 3 bolts.
- Remove and discard the gasket.

Installation

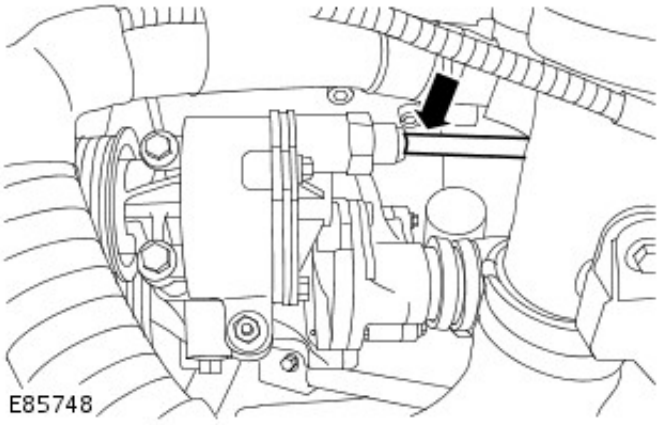


1. CAUTION: Install fixing bolts to previously noted positions.

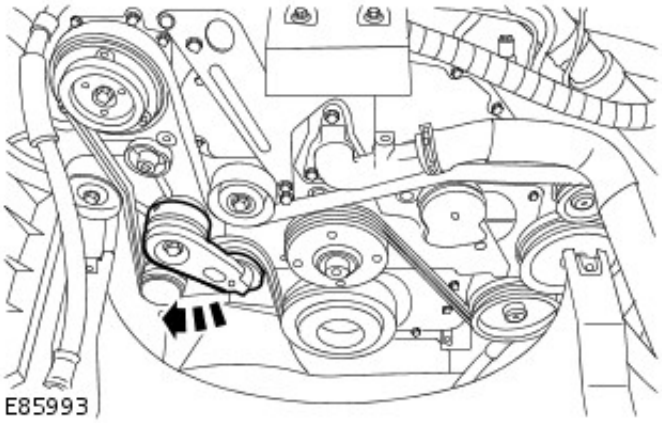
- NOTE: Remove and discard the blanking caps.
- NOTE: Clean the component mating faces.
- NOTE: Install a new gasket.

Install the brake vacuum pump.

- Tighten to 23 Nm (17 lb.ft).



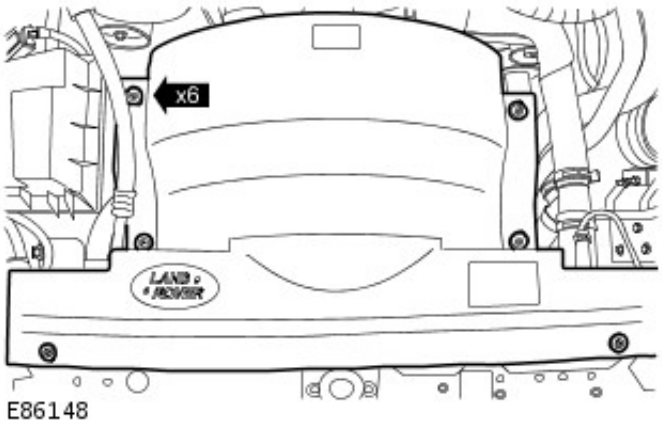
2. Connect the brake vacuum pump vacuum pipe.



3. NOTE: Cooling fan shown removed for clarity.

Install the accessory drive belt.

- Rotate the accessory drive belt tensioner clockwise.



4. Install the cooling fan upper shroud.

- Secure the 6 screws.

Anti-Lock Control - Traction Control - Anti-Lock Control - Traction Control
Diagnosis and Testing

Inspection and Verification

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

• 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 additional 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

DTC	Description	Possible cause	Action
12	Pump failure 1 - high level at C0504-8 without pump actuation	• ABS pump monitor circuit, short circuit to power • ABS pump relay contacts stuck closed	Refer to the electrical guides and check C0504-8 ABS pump monitor circuit for short circuit to power. Check ABS pump relay for stuck closed contacts.
13	Pump failure 2 - low level at C0504-8 during pump actuation	• ABS pump monitor circuit, short circuit to ground • ABS pump relay fuse failure • ABS pump relay battery supply circuit, Open circuit	Check for ABS pump relay fuse failure. Refer to the electrical guides and check C0504-8 ABS pump monitor circuit, for short circuit to ground. Check C0508-3 ABS pump relay battery supply circuit, for open circuit.
14	Pump failure 3 - pump sticks	• NOTE: The ABS pump is part of the ABS modulator assembly • Internal failure ABS pump	Refer to the warranty policy and procedures manual if ABS pump/ABS modulator is suspect.
15	Pump failure 4 - sticking pump relay	• ABS pump relay coil circuit, short circuit to power • ABS pump relay contacts stuck closed • ABS pump relay fault	Refer to the electrical guides and check C0506-15 ABS pump relay coil circuit, for short circuit to power. Check ABS pump relay for stuck closed contacts.
16	Failure of	• NOTE: The shuttle	Refer to the electrical guides and check resistance between C0506-3 reference

	the shuttle valve switch	valve switch's are integral to the ABS modulator • Shuttle valve switch circuit, high resistance • Shuttle valve switch circuit, open circuit • Internal failure shuttle valve switch's	ground sense and C0506-6 shuttle valve switch, brake pedal **not** pressed expected measurement 3K ohms, both shuttle valves switches are open. Check resistance between C0506-3 reference ground sense and C0506-6 shuttle valve switch, brake pedal pressed expected measurement 1K ohm, both shuttle valves switches are closed. Check between C0506-3 and C0501-8 reference ground sense circuit for open circuit, high resistance. Check between C0506-6 and C0501-9 shuttle valve switch circuit for open circuit, high resistance. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
17	Valve relay failure 1 - permanently powered on (can´t be switched off)	• Internal failure	Refer to the warranty policy and procedures manual if ABS pump/ABS modulator is suspect.
20	Valve relay failure 2 - no output (can´t be switched on)	• Internal failure	Refer to the warranty policy and procedures manual if ABS pump/ABS modulator is suspect.
21	Failure of the throttle position signal	• Torque, throttle, eng I.D circuit, open circuit	Refer to the electrical guides and check between C0504-10 and C0872-B1 for open circuit.
22	Reference earth C0506-3 not connected to ground	• Reference ground sense circuit, open circuit	Refer to the electrical guides and check C0506-3 reference ground sense circuit, for open circuit.
23	Gear info not plausible	• Open circuit	Refer to the electrical guides and check between C0504-10 and C0872-B1 for open circuit.
24	Sensor right hand front - sensor offset voltage out of range	• The wheel speed sensor air gap may be too large • Wheel speed sensor circuit high resistance • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms • The output of the wheel speed sensor may be intermittent	Check front right hand wheel speed sensor for correct air gap. Refer to the electrical guides and check front right hand wheel speed sensor circuit for high resistance. Check front right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms. Suspect front right hand wheel speed sensor.
25	Sensor left hand rear - sensor offset voltage out of range	• The wheel speed sensor air gap may be too large • Wheel speed sensor circuit high resistance • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms • The output of the wheel	Check rear left hand wheel speed sensor for correct air gap. Refer to the electrical guides and check rear left hand wheel speed sensor circuit for high resistance. Check rear left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms. Suspect rear left hand wheel speed sensor.

		speed sensor may be intermittent	
26	Sensor left hand front - sensor offset voltage out of range	• The wheel speed sensor air gap may be too large • Wheel speed sensor circuit high resistance • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms • The output of the wheel speed sensor may be intermittent	Check front left hand wheel speed sensor for correct air gap. Refer to the electrical guides and check front left hand wheel speed sensor circuit for high resistance. Check front left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms. Suspect front left hand wheel speed sensor.
27	Sensor right hand rear - sensor offset voltage out of range	• The wheel speed sensor air gap may be too large • Wheel speed sensor circuit high resistance • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms • The output of the wheel speed sensor may be intermittent	Check rear right hand wheel speed sensor for correct air gap. Refer to the electrical guides and check rear right hand wheel speed sensor circuit for high resistance. Check rear right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms. Suspect rear right hand wheel speed sensor.
30	Inlet valve right hand front - power amp with electrical connection interrupted	• Right hand front inlet valve circuit, open circuit	Refer to the electrical guides and check C0506-5 front right inlet modulator valve circuit for open circuit.
31	Outlet valve right hand front - power amp with electrical connection interrupted	• Right hand front outlet valve circuit, open circuit	Refer to the electrical guides and check C0506-4 front right outlet modulator valve circuit for open circuit.
32	Inlet valve left hand front - power amp with electrical connection interrupted	• Left hand front inlet valve circuit, open circuit	Refer to the electrical guides and check C0506-2 front left inlet modulator valve circuit for open circuit.
33	Outlet valve left hand front - power amp with electrical connection	• Left hand front outlet valve circuit, open circuit	Refer to the electrical guides and check C0506-1 front left outlet modulator valve circuit for open circuit.

	interrupted		
34	Inlet valve right hand rear - power amp with electrical connection interrupted	• Right hand rear inlet valve circuit, open circuit	Refer to the electrical guides and check C0506-11 rear right inlet modulator valve circuit for open circuit.
35	Outlet valve right hand rear - power amp with electrical connection interrupted	• Right hand rear outlet circuit, open circuit	Refer to the electrical guides and check C0506-10 rear right outlet modulator valve circuit for open circuit.
36	Inlet valve left hand rear - power amp with electrical connection interrupted	• Left hand rear inlet valve circuit, open circuit	Refer to the electrical guides and check C0506-8 rear left inlet modulator valve circuit for open circuit.
37	Outlet valve left hand rear - power amp with electrical connection interrupted	• Left hand rear outlet circuit, open circuit	Refer to the electrical guides and check C0506-7 rear left outlet modulator valve circuit for open circuit.
40	Pump relay - power amp with electrical connection interrupted	• ABS pump relay coil circuit, open circuit	Refer to the electrical guides and check C0506-15 ABS pump relay coil circuit for open circuit.
44	Sensor right hand front - sensor air gap too large	• Front right hand wheel speed sensor large air gap	Check front right hand wheel speed sensor for correct air gap.
45	Sensor left hand rear - sensor air gap too large	• Rear left hand wheel speed sensor large air gap	Check rear left hand wheel speed sensor for correct air gap.
46	Sensor left hand front - sensor air gap too large	• Front left hand wheel speed sensor large air gap	Check front left hand wheel speed sensor for correct air gap.
47	Sensor right hand rear - sensor air gap too large	• Rear right hand wheel speed sensor large air gap	Check rear right hand wheel speed sensor for correct air gap.
50	Inlet valve right hand front - power amp with short circuit to ground	• Right hand front inlet valve short circuit to ground	Refer to the electrical guides and check C0506-5 front right inlet modulator valve circuit for short circuit to ground.
51	Outlet valve right hand front - power amp with short circuit to ground	• Right hand front outlet valve short circuit to ground	Refer to the electrical guides and check C0506-4 front right outlet modulator valve circuit for short circuit to ground.
52	Inlet valve left hand front - power amp	• Left hand front inlet valve short circuit to ground	Refer to the electrical guides and check C0506-2 front left inlet modulator valve circuit for short circuit to ground.

	with short circuit to ground		
53	Outlet valve left hand front - power amp with short circuit to ground	• Left hand front outlet valve short circuit to ground	Refer to the electrical guides and check C0506-1 front left outlet modulator valve circuit for short circuit to ground.
54	Inlet valve right hand rear - power amp with short circuit to ground	• Right hand rear inlet valve short circuit to ground	Refer to the electrical guides and check C0506-11 rear right inlet modulator valve circuit for short circuit to ground.
55	Outlet valve right hand rear - power amp with short circuit to ground	• Right hand rear outlet valve short circuit to ground	Refer to the electrical guides and check C0506-10 rear right outlet modulator valve circuit for short circuit to ground.
56	Inlet valve left hand rear - power amp with short circuit to ground	• Left hand rear inlet valve short circuit to ground	Refer to the electrical guides and check C0506-8 rear left inlet modulator valve circuit for short circuit to ground.
57	Outlet valve left hand rear - power amp with short circuit to ground	• Left hand rear outlet valve short circuit to ground	Refer to the electrical guides and check C0506-7 rear left outlet modulator valve circuit for short circuit to ground.
60	Pump relay - power amp with short circuit to ground	• ABS pump relay coil circuit, short circuit to ground	Refer to the electrical guides and check C0506-15 ABS pump relay coil circuit for short circuit to ground.
64	Sensor right hand front - sensor DC-failure	• Wheel speed sensor circuit, open circuit • Wheel speed sensor circuit, short circuit to ground • Wheel speed sensor circuit, short circuit to power • Wheel speed sensor failure	Refer to the electrical guides and check front right hand wheel speed sensor circuit for open circuit, short circuit to ground, short circuit to power. Check front right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
65	Sensor left hand rear - sensor DC-failure	• Wheel speed sensor circuit, open circuit • Wheel speed sensor circuit, short circuit to ground • Wheel speed sensor circuit, short circuit to power • Wheel speed sensor failure	Refer to the electrical guides and check rear left hand wheel speed sensor circuit for open circuit, short circuit to ground, short circuit to power. Check rear left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
66	Sensor left hand front - sensor DC-failure	• Wheel speed sensor circuit, open circuit • Wheel speed sensor circuit, short circuit to	Refer to the electrical guides and check front left hand wheel speed sensor circuit for open circuit, short circuit to ground, short circuit to power. Check front left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.

		ground • Wheel speed sensor circuit, short circuit to power • Wheel speed sensor failure	
67	Sensor right hand rear - sensor DC-failure	• Wheel speed sensor circuit, open circuit • Wheel speed sensor circuit, short circuit to ground • Wheel speed sensor circuit, short circuit to power • Wheel speed sensor failure	Refer to the electrical guides and check rear right hand wheel speed sensor circuit for open circuit, short circuit to ground, short circuit to power. Check rear right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
70	Inlet valve right hand front - power amp with short circuit to Uvent	• Right hand front inlet valve circuit, short circuit to reference ground • Right hand front inlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-5 front right inlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
71	Outlet valve right hand front - power amp with short circuit to Uvent	• Right hand front outlet valve circuit, short circuit to reference ground • Right hand front outlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-4 front right outlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
72	Inlet valve left hand front - power amp with short circuit to Uvent	• Left hand front inlet valve circuit, short circuit to reference ground • Left hand front inlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-2 front left inlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
73	Outlet valve left hand front - power amp with short circuit to Uvent	• Left hand front outlet valve circuit, short circuit to reference ground • Left hand front outlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-1 front left outlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
74	Inlet valve right hand rear - power amp with short circuit to Uvent	• Right hand rear inlet valve circuit, short circuit to reference ground • Right hand rear inlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-11 rear right inlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
75	Outlet valve	• Right hand	Refer to the electrical guides and check harness for short circuit between

	right hand rear - power amp with short circuit to Uvent	rear outlet valve circuit, short circuit to reference ground • Right hand rear outlet valve internal failure	C0506-10 rear right outlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
76	Inlet valve left hand rear - power amp with short circuit to Uvent	• Left hand rear inlet valve circuit, short circuit to reference ground • Left hand rear inlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-8 rear left inlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
77	Outlet valve left hand rear - power amp with short circuit to Uvent	• Left hand rear outlet valve circuit, short circuit to reference ground • Left hand rear outlet valve internal failure	Refer to the electrical guides and check harness for short circuit between C0506-7 rear left outlet modulator valve circuit and C0506-3 reference ground sense circuit. Refer to the warranty policy and procedures manual if ABS modulator is suspect.
80	Pump relay - power amp. with short circuit to Uvent	• ABS pump relay coil circuit, short circuit to reference ground	Refer to the electrical guides and check harness for short circuit between C0506-15 ABS pump relay coil circuit and C0506-3 reference ground sense circuit.
84	Sensor right hand front - intermittent sensor output during driving	• The output of the wheel speed sensor may be intermittent • Wheel speed sensor air gap to large • Wheel speed sensor circuit high resistance • Wheel speed sensor circuit, open circuit • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms	Check front right hand wheel speed sensor for correct air gap. Refer to the electrical guides and check front right hand wheel speed sensor circuit for high resistance, open circuit. Check front right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
85	Sensor left hand rear - intermittent sensor output during driving	• The output of the wheel speed sensor may be intermittent • Wheel speed sensor air gap to large • Wheel speed sensor circuit high resistance • Wheel speed sensor circuit, open circuit • The resistance of the wheel	Check rear left hand wheel speed sensor for correct air gap. Refer to the electrical guides and check rear left hand wheel speed sensor circuit for high resistance, open circuit. Check rear left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.

		speed sensor changed from the nominal value of 950±80 ohms	
86	Sensor left hand front - intermittent sensor output during driving	• The output of the wheel speed sensor may be intermittent • Wheel speed sensor air gap to large • Wheel speed sensor circuit high resistance • Wheel speed sensor circuit, open circuit • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms	Check front left hand wheel speed sensor for correct air gap. Refer to the electrical guides and check front left hand wheel speed sensor circuit for high resistance, open circuit. Check front left hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
87	Sensor right hand rear - intermittent sensor output during driving	• The output of the wheel speed sensor may be intermittent • Wheel speed sensor air gap to large • Wheel speed sensor circuit high resistance • Wheel speed sensor circuit, open circuit • The resistance of the wheel speed sensor changed from the nominal value of 950±80 ohms	Check rear right hand wheel speed sensor for correct air gap. Refer to the electrical guides and check rear right hand wheel speed sensor circuit for high resistance, open circuit. Check rear right hand wheel speed sensor resistance for correct nominal value of 950±80 ohms.
90	Inlet valve right hand front - power amp with short circuit to Ubatt	• Right hand front inlet valve short circuit to power	Refer to the electrical guides and check C0506-5 front right inlet modulator valve circuit for short circuit to power.
91	Outlet valve right hand front - power amp with short circuit to Ubatt	• Right hand front outlet valve short circuit to power	Refer to the electrical guides and check C0506-4 front right outlet modulator valve circuit for short circuit to power.
92	Inlet valve left hand front - power amp with short circuit to Ubatt	• Left hand front inlet valve short circuit to power	Refer to the electrical guides and check C0506-2 front left inlet modulator valve circuit for short circuit to power.
93	Outlet valve left hand front - power amp	• Left hand front outlet valve short circuit to power	Refer to the electrical guides and check C0506-1 front left outlet modulator valve circuit for short circuit to power.

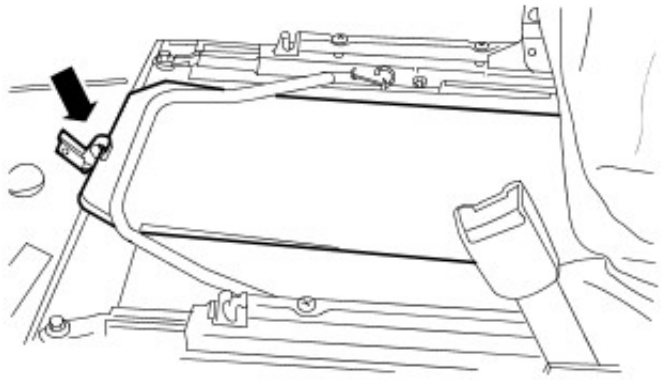
	with short circuit to Ubatt		
94	Inlet valve right hand rear - power amp with short circuit to Ubatt	• Right hand rear inlet valve short circuit to power	Refer to the electrical guides and check C0506-11 rear right inlet modulator valve circuit for short circuit to power.
95	Outlet valve right hand rear - power amp with short circuit to Ubatt	• Right hand rear outlet valve short circuit to power	Refer to the electrical guides and check C0506-10 rear right outlet modulator valve circuit for short circuit to power.
96	Inlet valve left hand rear - power amp with short circuit to Ubatt	• Left hand rear inlet valve short circuit to power	Refer to the electrical guides and check C0506-8 rear left inlet modulator valve circuit for short circuit to power.
97	Outlet valve left hand rear - power amp with short circuit to Ubatt	• Left hand rear outlet valve short circuit to power	Refer to the electrical guides and check C0506-7 rear left outlet modulator valve circuit for short circuit to power.
100	Pump relay - power amp with short circuit to Ubatt	• ABS pump relay coil circuit, short circuit to power	Refer to the electrical guides and check C0506-15 ABS pump relay coil circuit for short circuit to power.
104	Sensor right hand front - no sensor output at all	• Front right hand wheel speed sensor extremely large air gap • Tone ring broken/missing	Check front right hand wheel speed sensor for correct air gap. Check tone ring is not damaged or missing.
105	Sensor left hand rear - no sensor output at all	• Rear left hand wheel speed sensor extremely large air gap • Tone ring broken/missing	Check rear left hand wheel speed sensor for correct air gap. Check tone ring is not damaged or missing.
106	Sensor left hand front - no sensor output at all	• Front left hand wheel speed sensor extremely large air gap • Tone ring broken/missing	Check front left hand wheel speed sensor for correct air gap. Check tone ring is not damaged or missing.
107	Sensor right hand rear - no sensor output at all	• Rear right hand wheel speed sensor extremely large air gap • Tone ring broken/missing	Check rear right hand wheel speed sensor for correct air gap. Check tone ring is not damaged or missing.

Anti-Lock Control - Traction Control - Anti-Lock Brake System (ABS) Module

Removal and Installation

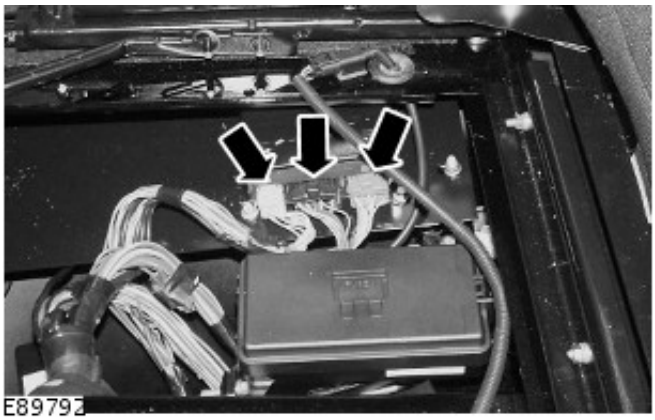
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the RH front seat cushion.
   For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).
3. Remove the anti-lock brake system (ABS) module cover.
   - Release the clip.



E89791

4. Disconnect the 3 electrical connectors from the ABS module.



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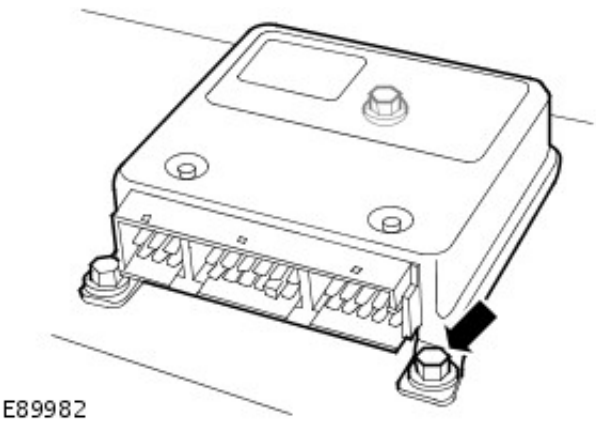
5. Remove the ABS module.
   - Remove the 3 bolts.



E89982

Installation

1. Install the ABS module.
   - Tighten the bolts to 10 Nm (7 lb.ft).
2. Connect the ABS module electrical connectors.
3. Install the ABS module cover.

- Secure with the clip.

4. Install the RH front seat cushion.
   For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).
5. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

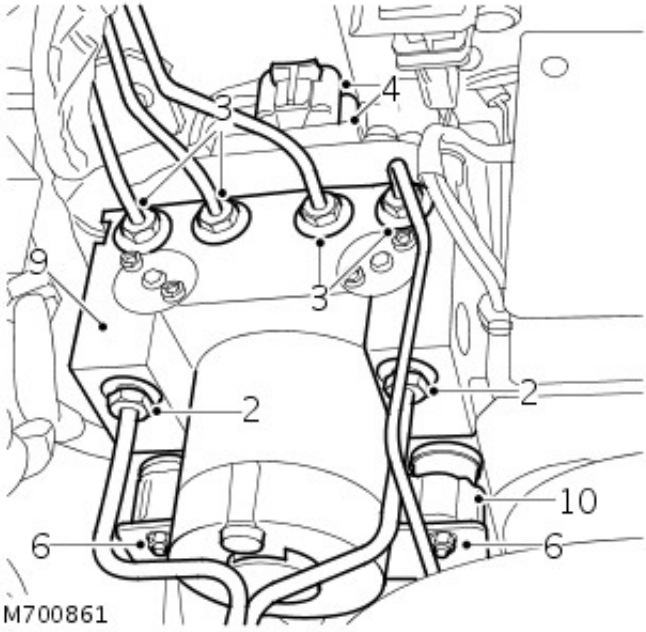
Anti-Lock Control - Traction Control - Hydraulic Control Unit (HCU)

Removal and Installation

Removal

1. Position cloth under modulator to absorb any fluid spillage.
2. Disconnect 2 inlet brake pipe unions from pump side of modulator.
3. CAUTION: Plug the connections.

   Disconnect 4 outlet brake pipe unions from top of modulator.
4. Disconnect 2 multiplugs from rear of modulator.
5. Loosen nut securing rear of modulator to mounting bracket.
6. Remove 2 nuts securing front of modulator to mounting bracket.
7. Release modulator from mounting bracket.
8. Disconnect multiplug from base of modulator.
9. Remove modulator.
10. Remove 3 mounting rubbers from old modulator and fit to new.



Installation

1. Position modulator to mounting bracket and connect multiplug.
2. Instal modulator to mounting bracket and tighten nuts to 9 Nm (7 lbf.ft) .
3. Connect 2 multiplugs to rear of modulator.
4. Remove plugs from brake pipes and modulator.
5. Clean brake pipe unions.
6. Connect brake pipe unions to modulator ensuring pipes are connected to their correct ports.
7. Tighten all unions to 14 Nm (10 lbf.ft).
8. NOTE: To ensure correct operation, the ABS system MUST be tested using TestBook.

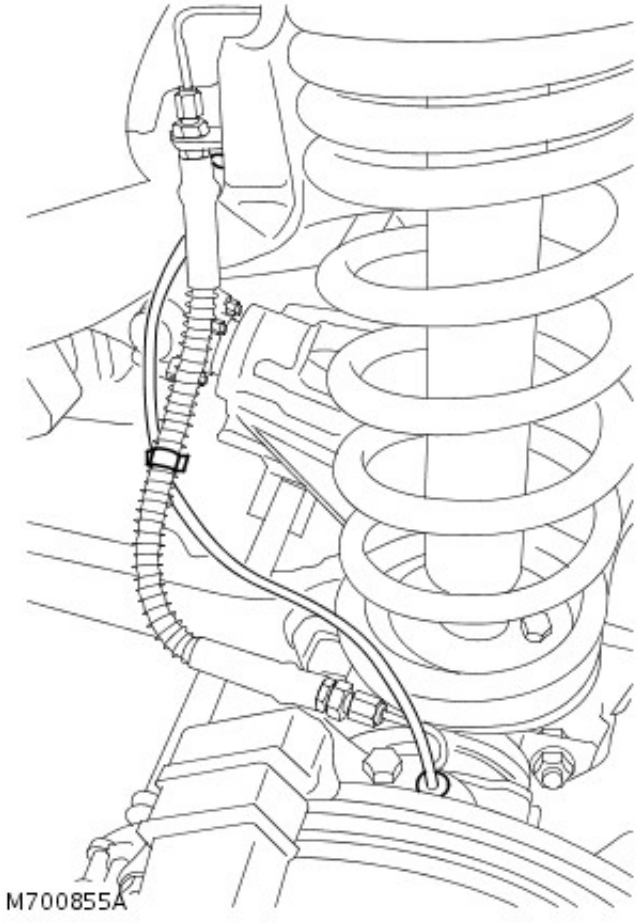
   Bleed brake system.
   For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).

Anti-Lock Control - Traction Control - Front Wheel Speed Sensor

Removal and Installation

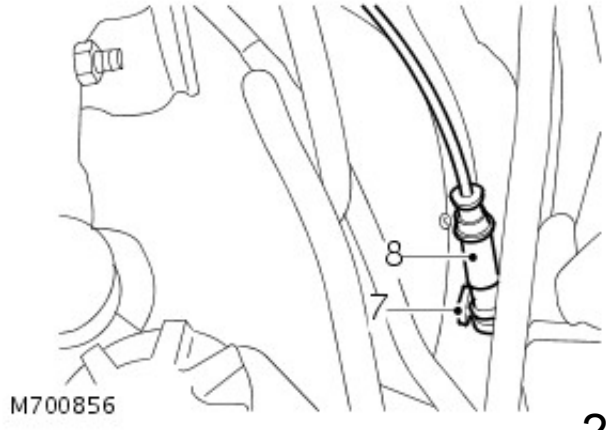
Removal

CAUTION: The sensor is not to be replaced without first removing the sensor, cleaning it, repositioning and retesting.



1. Raise vehicle on a 2 post ramp.
2. CAUTION: The sensor is not to be replaced without first removing the sensor, cleaning it, repositioning and retesting.

   Carefully prise ABS sensor from front hub.
3. Release clip securing ABS sensor harness to brake pipe.
4. Release clip securing ABS sensor harness to inner wing.
5. Lower vehicle.
6. Release second clip securing ABS harness to inner wing.
7. Disconnect sensor harness multiplug.
8. Remove sensor and harness.



Installation

1. Connect sensor harness multiplug.
2. Position sensor harness and secure to inner wing with clip.
3. Raise vehicle.
4. Secure harness to inner wing and brake pipe with clips.
5. Apply grease to sensor.

CAUTION: Ensure sensors are thoroughly cleaned before fitting.

6. Carefully install sensor to hub assembly.
7. Lower vehicle.

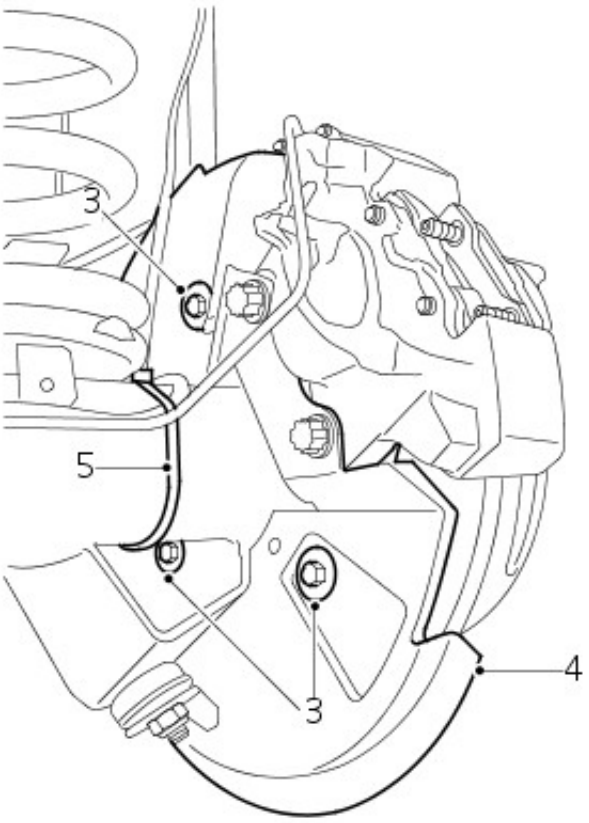
Anti-Lock Control - Traction Control - Rear Wheel Speed Sensor

Removal and Installation

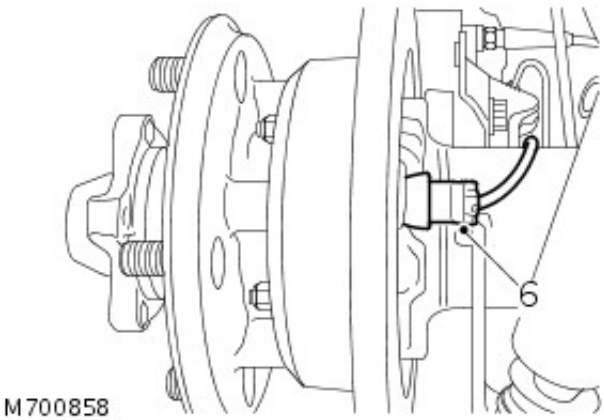
Removal

CAUTION: The sensor is not to be replaced without first removing the sensor, cleaning it, repositioning and retesting.

1. Raise vehicle on a 2 post ramp.
2. Remove both rear wheels.
3. Remove 3 bolts securing each brake disc backplate to hub assemblies.
4. Remove both back plates.
5. Remove 2 cable ties securing sensor harness to outer ends of axle.



M700857

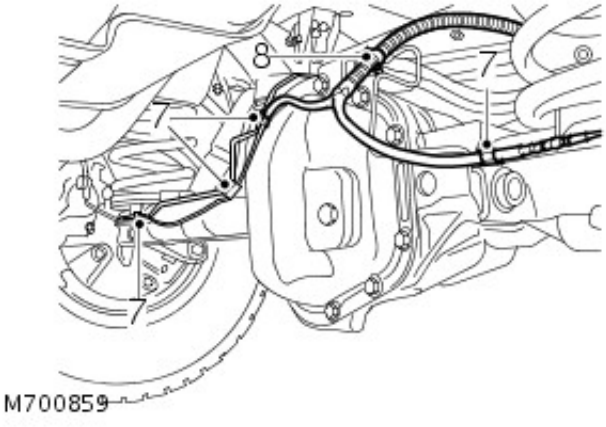


M700858

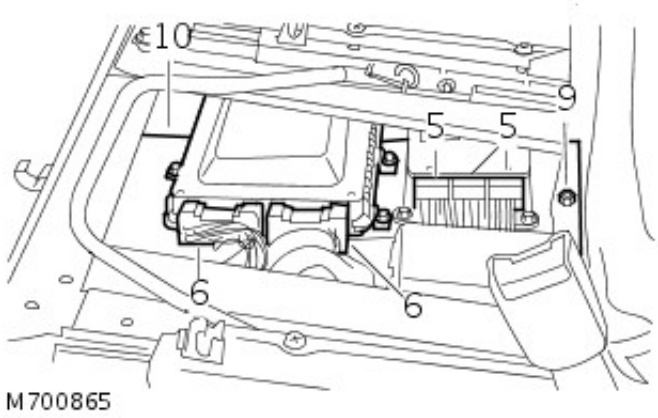
6. CAUTION: The sensor is not to be replaced without first removing the sensor, cleaning it, repositioning and retesting.

   Carefully prise both sensors from hub assemblies.

7. Release 4 clips securing sensor harness to axle.



8. Release cable tie securing harness to differential.
9. Release 3 cable ties securing harness to chassis longitudinal.
10. Disconnect sensor multiplug.
11. Remove harness and sensor assembly.



Installation

1. Position harness and sensor assembly to vehicle and connect multiplug.
2. Apply grease to both sensors.
3. CAUTION: Ensure sensors are thoroughly cleaned before fitting.

   Carefully install both sensors to hub assemblies.
4. Secure harness to axle and differential with cable ties.
5. Secure harness to axle with clips.
6. Secure harness to chassis with cable ties.
7. Install both back plates to hub assemblies and secure with bolts.
8. Install rear wheels and tighten to 130 Nm (95 lbf.ft).
9. Lower vehicle.

Steering System - General Information -

Steering

Steering geometry	
Steering wheel diameter	412 mm (16.22 in)
Front wheel alignment	-10' ± 10' toe-out
Rear wheel alignment	+5' ± 15' toe-in
Camber angle - Front	-10' ± 45'
Camber angle - Rear	-10' ± 45'
Castor angle	3° 15' ± 45'
Cross castor	1° Maximum
Cross camber - Front	1° Maximum
Cross camber - Rear	1° Maximum
Swivel pin inclination - static	7° Check with vehicle on level ground at EEC kerb weight. Rock the front of the vehicle up and down to allow it to take up normal static position.

Turning circle between kerbs	
90 Models	
265/75 x 16 tires	12.65 m (41.5 ft)
All other tires	11.70 m (38.4 ft)
110 Models	
750 x 16 tires	13.41 m (44 ft)
130 Models	
750 x 16 tires	15.24 m (50 ft)

Steering box and pump	
Steering box make and type	Adwest Varamatic - worm and roller
Steering box ratio	Variable: Straight ahead - 19.3:1 on lock - 14.3:1
Steering wheel turns - lock to lock	3.375
Steering pump make and type	JTekt P4

Power steering system

Fluids and capacities	
Power steering fluid	Texaco Cold Climate 33270
Fluid capacity - steering gear and reservoir - LHD	2.90 litres (5.0 pints)
Fluid capacity - steering gear and reservoir - RHD	3.40 litres (6.00 pints)

Torque specifications

Description	Nm	lbf-ft
Drag link to drop arm	40	30
Ball joint nuts	40	30
Clamp bolt (M6)	9	7
Steering column bracket nuts	22	16
Steering wheel nut	43	32
Tie bar to mounting nut initial torque	80	60
Tie bar to mounting nut final torque	110	80
Universal joint pinch bolt	30	22
Steering gear adjuster locknut	60	45
Steering gear drop arm nut	175	130
Steering gear sector shaft cover to steering box	75	55
Steering gear to chassis	80	60
Steering gear fluid pipes 14mm thread	15	11
Steering gear fluid pipes 16mm thread	20	15
Steering gear tie bar	80	60
Power steering pump high pressure fluid pipe	20	15
Power steering pump mounting	35	25
Power steering pump pulley bolts	10	7
Power steering pump hose clamp	3	2
Power steering pump front mounting plate bolts	9	7
Power steering reservoir hose clamp	3	2

Fixing size	Nm	lbf-ft

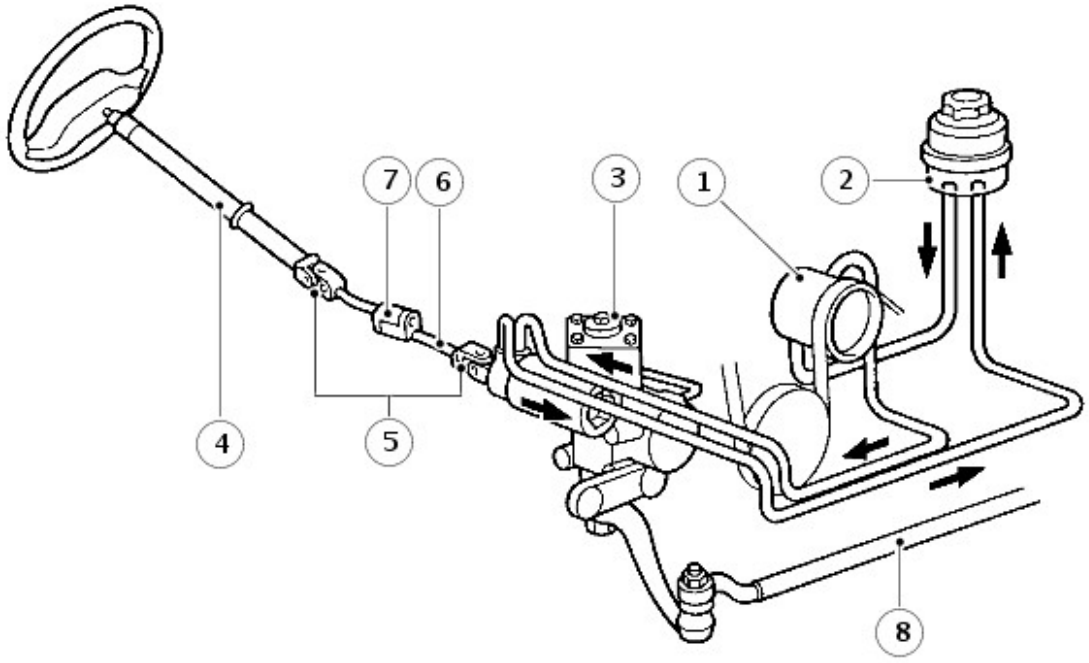
M5	6	4.5
M6	9	7
M8	25	18
M10	45	33
M12	90	65
M14	105	77
M16	180	133
1/4 in	9	7
5/16 in	24	18
3/8 in	39	29
7/16 in	78	58
½ in	90	65
5/8 in	135	100

Torque specifications in the table above are for all screws and bolts used, except for those specifically referred to in the Torque specifications table.

Steering System - General Information - Steering System

Description and Operation

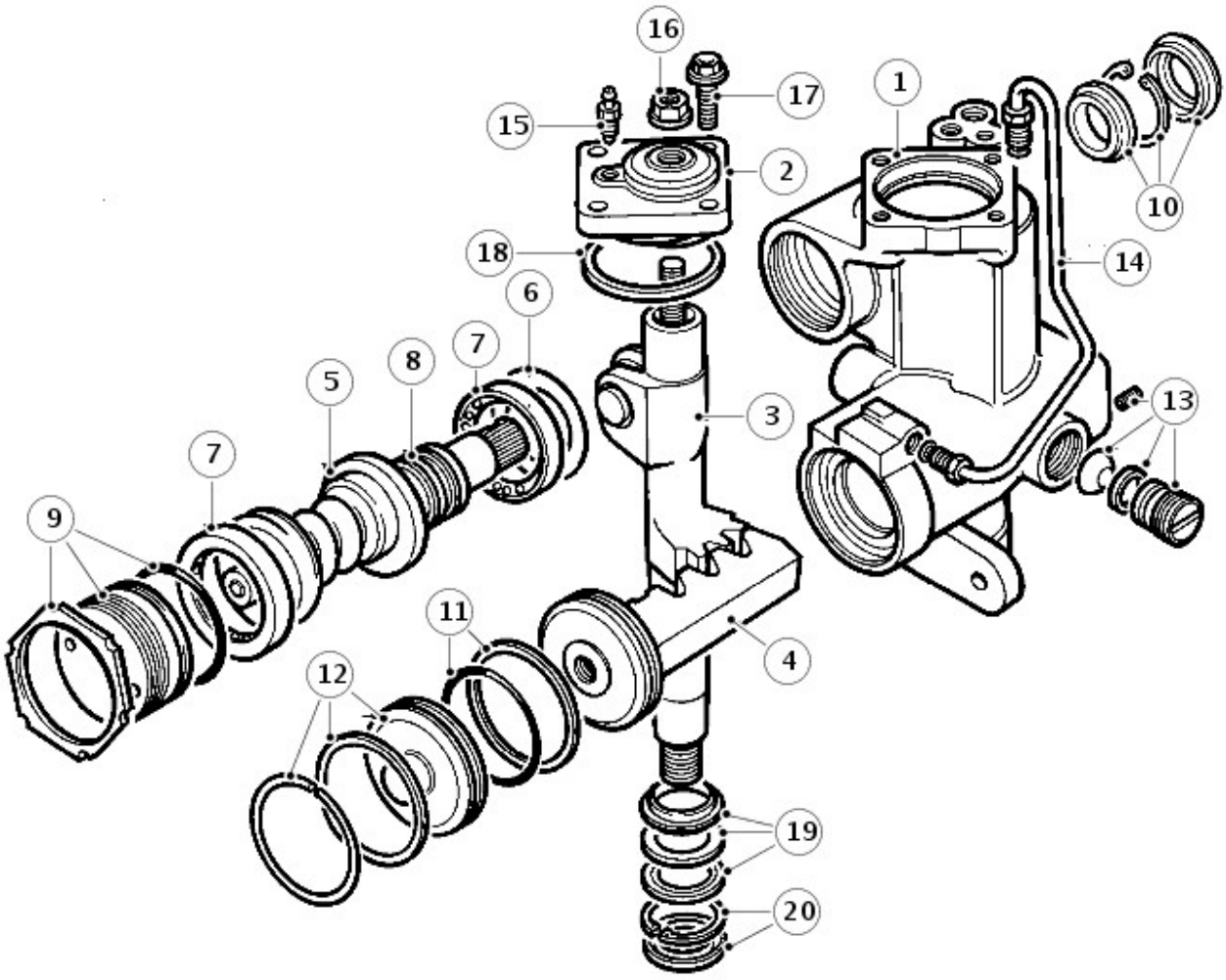
Power steering system



J6291

Item	Part Number	Description
1.	-	Hydraulic pump
2.	-	Fluid reservoir
3.	-	Steering box
4.	-	Upper column
5.	-	Universal joints
6.	-	Lower shaft
7.	-	Compression joint
8.	-	Drag link

Power steering box components



RR4149

Item	Part Number	Description
1.	-	Housing complete with sector shaft bearings
2.	-	Cover plate complete with bearing
3.	-	Sector shaft
4.	-	Hydraulic piston/rack
5.	-	Worm/valve and torsion bar assembly
6.	-	Shims for centralizing worm/valve
7.	-	Ball race
8.	-	'Teflon' seals for valve sleeve
9.	-	Bearing adjuster, locknut and seal
10.	-	Worm shaft pressure seal, circlip and dirt excluder
11.	-	'Teflon' and rubber seal for piston
12.	-	End cover seal and snap ring
13.	-	Adjustment components for piston/rack
14.	-	Hydraulic pipe
15.	-	Bleed screw
16.	-	Sector shaft adjustment lock nut with seal
17.	-	Cover plate bolts
18.	-	Cover plate seal
19.	-	Seal, washer and backup seal
20.	-	Circlip and dust cover

GENERAL

The steering system incorporates a compression joint in the lower shaft and is designed to collapse on impact. The mis-alignment of the upper steering column with the steering box and the inclusion of two universal joints, is also designed to prevent the column moving toward the driver under frontal impact.

The steering box is located behind the first chassis cross member and is connected to the road wheel swivel housing by a drag link and track rod. A hydraulic damper absorbs shocks in the steering, caused by road wheel deflections when operating on rough terrain.

Power steering system

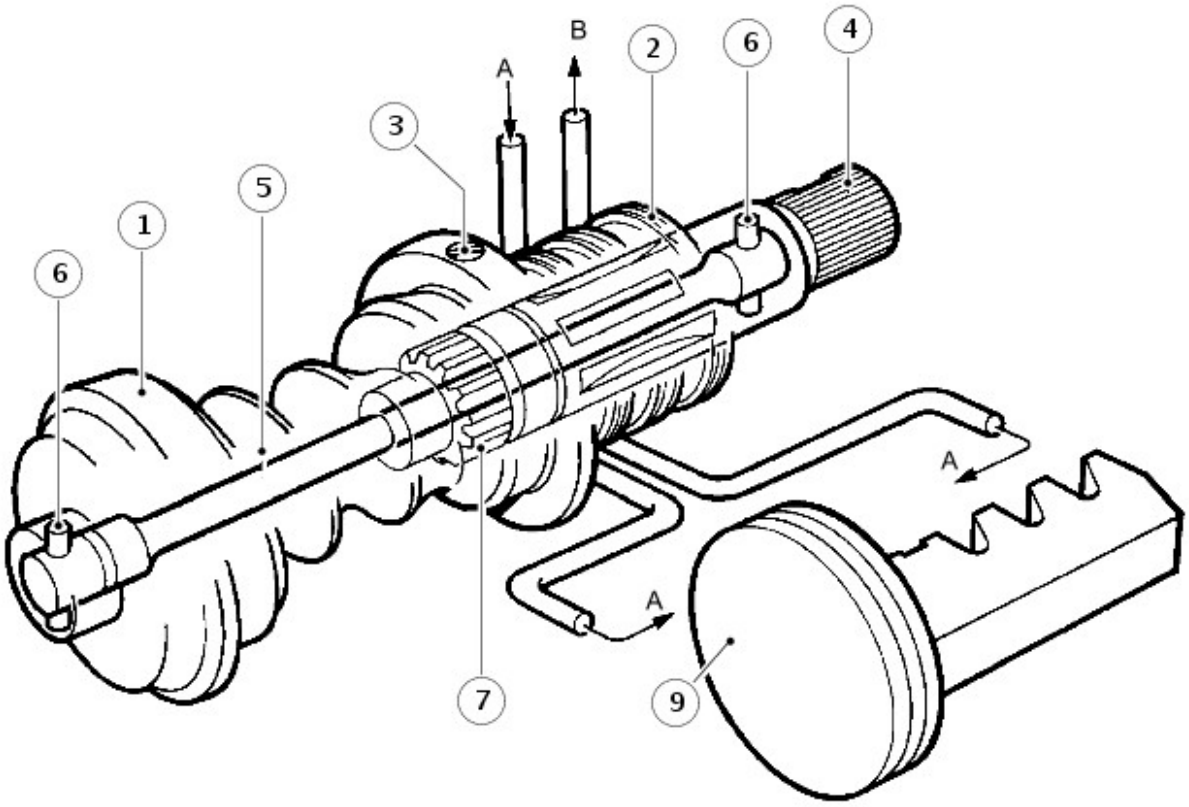
The power steering system comprises a hydraulic pump which is belt driven from the engine and supplied with fluid from

a reservoir that also acts as a cooler.

The steering box houses a self neutralizing rotary valve which is part of the worm/valve assy and an hydraulic piston/rack to assist the mechanical operation. The rotary valve which is operated by movement of the steering wheel, directs fluid pressure to the appropriate side of the hydraulic piston/rack to provide assistance.

Rotary valve operation

Rotary valve at neutral



RR3620M

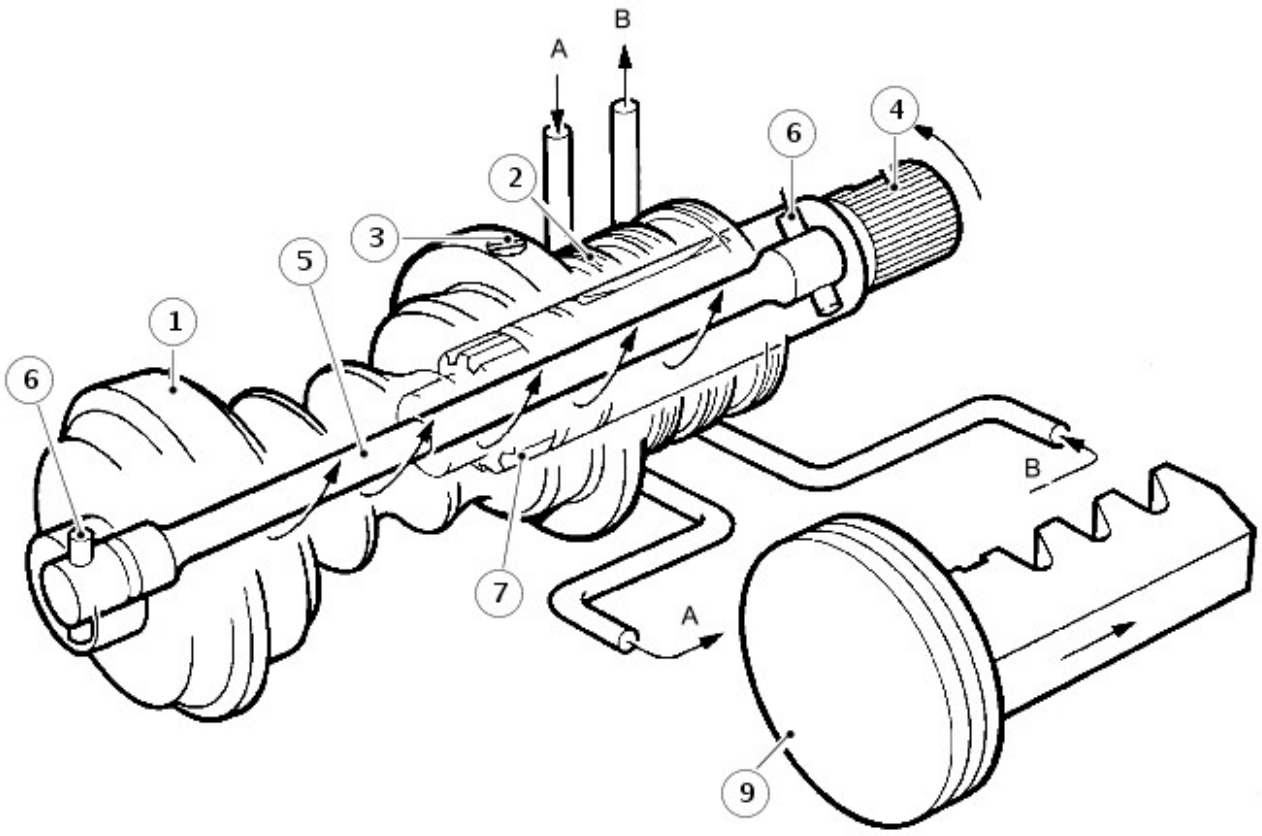
The rotary valve assembly comprises a worm (1), valve sleeve (2), input shaft (4) and torsion bar (5).

The valve sleeve is retained inside the worm by a trim screw (3), and incorporates valve ports in its inner bore. The input shaft is attached to the steering wheel via a steering shaft and steering column and incorporates valve ports in its outer diameter to align with those in the sleeve.

The torsion bar, which is secured to the worm and input shaft with pins (6) at each end, holds the valve ports in neutral alignment when there is no demand for assistance.

When there is no demand for assistance the torsion bar holds the input shaft and sleeve valve ports in neutral relationship to one another, allowing equal pump pressure (A) to both sides of the piston/rack (9). Any excess fluid flow from the pump returns to the reservoir via (B).

Rotary valve misaligned



RR3621M

When the steering wheel and input shaft is turned, steering resistance transmitted to the worm causes the torsion bar to be twisted and the valve ports to be misaligned for a right or left turn. The misalignment of the valve ports directs all fluid pressure A to one side of the piston only and allows displaced fluid B on the other side.

When demanding maximum assistance, any excessive fluid output from the pump due to high pump speed, will circulate through the regulator valve located in the pump unit, causing the temperature of the fluid and the pump to rise rapidly.

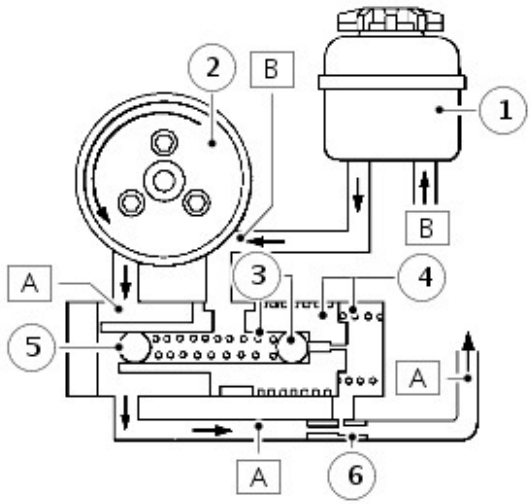
⚠CAUTION: To avoid excessive fluid temperatures which could damage the oil seals, the steering must not be held on full lock for more than 30 seconds in one minute.

Only when the steering wheel, and the demand for assistance, is released, will the torsion bar return the valve to neutral, allowing the fluid to circulate through the reservoir where it is cooled.

In the unlikely event of mechanical failure of the torsion bar, a coarse splined connection (7) between the input shaft and worm, ensures steering control is maintained sufficient to allow the vehicle to be recovered.

Pump and regulator valve operation

No demand for assistance



J6292

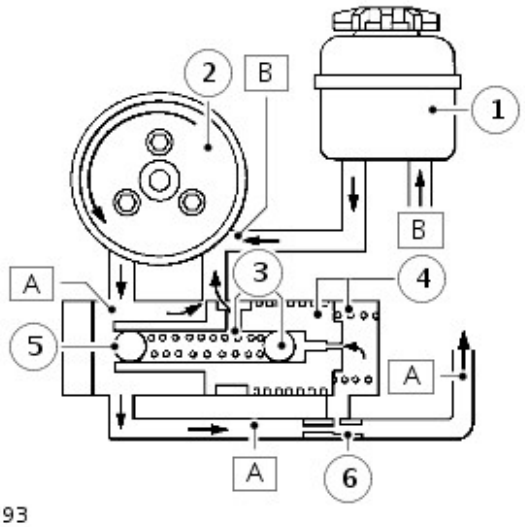
Item	Part Number	Description
1.	-	Reservoir
2.	-	Pump
3.	-	Pressure control ball valve and spring
4.	-	Flow control valve and spring
4.	-	Press fit plug (ball bearing)
5.	-	Restrictor

The pump which is belt driven from the engine is an eccentric roller type and also houses the pressure regulator and flow control valve. The pressure is controlled by a spring loaded ball valve (3) which is housed inside the flow control valve piston (4).

With no demand for assistance the rotary valve in the steering box acts as a pressure relief valve, allowing fluid (A) to flow freely through the steering box and back to the reservoir and pump inlet (B).

When the steering is turned, the rotary valve effectively stops all fluid flow through the steering box, thus causing an increase in pressure (A). This increase in pressure is felt in the flow control valve spring chamber where, at a pre-determined pressure the relief valve (3) will open and allow the pressure to escape. The fall in pressure in the flow control spring chamber, allows the flow control valve to move to the right, which in turn allows pump output (A) to escape directly into the pump inlet (B).

Assistance demanded



J6293

As soon as the steering wheel is released after making a turn, the system reverts to the condition seen in J6292 and the road wheels are returned to the straight ahead position by the mechanical steering geometry.

In the event of any hydraulic failure, steering control, though heavy, will be maintained through the mechanical components in the steering box.

Steering System - General Information - Steering System

Diagnosis and Testing

Symptom Chart

Power steering pressure faults

CAUTION: Do not hold steering wheel on full lock for more than 30 seconds in any one minute to avoid overheating fluid and possibly damaging seals.

Excessive pressure in the system is almost always caused by a faulty relief valve in the PAS pump.

Insufficient pressure in the system is usually caused by low fluid level or PAS pump drive belt slip, or one of the following: PAS system leaks, faulty PAS pump relief valve, fault in steering box valve and worm assembly, leak at piston in steering box, worn components in PAS pump or box.

Symptom	Possible Sources	Action
Insufficient power assistance	* Fluid leaks	* Check for leaks, top-up reservoir.
	* Incorrect system pressures	* Carry out pressure test.
	* Power steering pump drive belt	* Check for contamination and/or correct tension.

Steering linkage faults

Symptom	Possible Sources	Action
Excessive kickback through steering wheel	* Faulty steering damper	* Replace steering damper
	* Looseness or free play in steering linkage	* Check steering linkage and replace worn or faulty components.
	* Looseness or worn bushes in front suspension	* Check suspension and replace worn or faulty components. - When replacing suspension bushes, ALL bushes and fixings must be replaced.
	* Swivel hub resistance incorrect	* Check swivel pin bearing pre-load.

Fluid leaks

CAUTION: The steering wheel must not be held on full lock for more than 30 seconds in one minute, as this may overheat the fluid and cause damage to the oil seals.

Symptom	Possible Sources	Action
Fluid leaks from steering box	* Excessive system pressure	* Replace power steering pump. If problems persist, overhaul the steering box.
Power steering fluid leaks	* Incorrect fluid level.	* Refill or drain to the correct level.
	* Leak from hoses and/or joints.	* Slacken and re-torque unions. Replace faulty pipes or hoses.
	* Fluid escaping from filler cap.	* Bleed power steering system.
	* Worn or damaged seal in steering system component.	* Replace faulty seal(s).

Insufficient power assistance - normal castor return action

Symptom	Possible Sources	Action
Insufficient power assistance	* Incorrect tire pressures or incorrect type of tire	* Adjust tire pressures and/or replace tires.
	* Low fluid level or air locks in the system	* Top-up fluid level, bleed the fluid system.
	* Incorrect system pressures.	* Check system pressures and bleed system. If fault persists, replace power steering pump and/or overhaul steering box.

Steering heavy/stiff - poor castor return action

Symptom	Possible Sources	Action
Stiff or heavy steering	* Incorrect type of tire or incorrect pressure.	* Fit correct tires or inflate to correct pressure.
	* Universal joint incorrectly aligned or seized.	* Free off or replace universal joint, align correctly.
	* Steering box incorrectly adjusted.	* Adjust steering box. REFER to: Steering Gear Adjustment (211-00 Steering System - General Information, General Procedures).
	* Steering ball joints seized.	* Replace seized components.
	* Swivel pins require lubrication or bearing preload resetting.	* Lubricate swivel pins or set bearing preload.
	* Steering box worn or seized.	* Overhaul steering box.

Steering excessively light/sensitive. Excessive free play at steering wheel

WARNING: Adjustments of steering box should not be required while in warranty period. If box is within warranty, it must be returned to manufacturer. No attempt must be made to introduce backlash.

Symptom	Possible Sources	Action
Light steering/excessive free play	* Incorrectly adjusted steering box	* Adjust steering box. REFER to: Steering Gear Adjustment (211-00 Steering System - General Information, General Procedures).

	* Worn panhard rod or radius arm bushes. Check condition of ball joints and the lower steering column shaft universal joint for wear.	* Replace worn/faulty components.

Steering vibration, road wheel shimmy - wobble

• NOTE: Vibration through the steering linkage powerful enough to induce high frequency oscillation of the steering wheel, is generally caused by out of balance road wheels. However there are a number of other possible causes of this symptom which, if severe, may be described as shimmy or wobble. Regardless of the terminology used by the owner/driver to describe the symptoms, the following diagnostic checks should be carried out in the order presented.

Symptom	Possible Sources	Action
Steering vibration	* Balance of road wheel, condition/specification of tires.	* Balance wheels, replace faulty or incorrect specification tires.
	* Faulty steering damper.	* Replace steering damper.
	* Worn/alignment of universal joints.	* Replace worn components, align joints correctly.
	* Worn steering linkage ball joints, including steering box and tie rod.	* Replace worn or damaged components.
	* Worn suspension bushes. Incorrectly tightened fixings.	* Replace worn or damaged components. Ensure all fixings are tightened to correct torque with vehicle wheels on the ground. * If problem persists, fit the following damper kits: - 90 Models - STC288 (front) and STC 289 (rear) - 110/130 Models - STC290 (front) - 110 Models (levelled) - STC291 (rear) - 110 Models (unlevelled) - STC92 (rear) - 130 Models - STC293 (rear)
	* Incorrectly adjusted power steering box.	* Adjust steering box. REFER to: Steering Gear Adjustment (211-00 Steering System - General Information, General Procedures).
	* Excessive hub bearing end-float.	* Check condition of hub bearings and adjust end-float as necessary.
	* Swivel joints incorrectly set.	* Adjust swivel pin bearing preload.
	* Steering geometry out of specification.	* Carry out full steering geometry check.

Steering veer

Symptom	Possible Sources	Action
Steering veer - not under baking	* Unevenly worn or faulty front tires.	* Inspect tires. Swap position (left to right) of front tires. If vehicle veers in opposite direction, replace tires. If problem solved, leave tires in new positions.
	* Steering box not centralised.	* Centralise steering box. REFER to: Steering Gear Centralization (211-00 Steering System - General Information, General Procedures).
Steering veer - under braking	* Air in brake system	* Carry out bleeding procedure. REFER to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
	* Brake pads glazed	* Remove glaze or replace brake pads.
	* Swivel pin bearing preload incorrectly set	* Adjust swivel pin bearing preload.

Directional stability

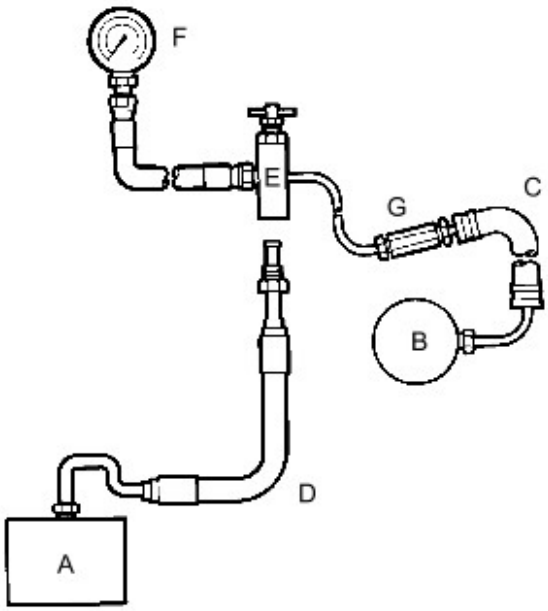
Symptom	Possible Sources	Action
Stability	* Vehicle overloaded or load incorrectly positioned.	* Check vehicle loading parameters in Owner Handbook.
	* Rear trailing link/chassis bushes worn.	* Replace worn components.
	* Worn front and rear shock absorbers.	* Replace worn components.
	* Faulty steering damper.	* Replace steering damper.
	* Road wheels out of balance.	* Balance the road wheels.

Power steering system - excessive noise

Symptom	Possible Sources	Action
Excessive noise	* Incorrect fluid level.	* Refill or drain to the correct level.
	* Hoses fouling vehicle body.	* Re-route hoses away from vehicle body.
	* PAS drive belt tension	* Re-tension drive belt.
	* Air in power steering system.	* Bleed power steering system.
	* Faulty steering box and/or pump.	* Replace faulty components.

POWER STEERING SYSTEM TEST

• NOTE: If steering lacks power assistance. Check pressure of hydraulic pump before fitting new components. Use fault diagnosis chart to assist in tracing faults.



RR3959M

Item	Part Number	Description
A.	-	Steering box
B.	-	Steering pump
C.	-	Existing hose, steering box to pump
D.	-	Hose LRT-57-030
E.	-	Test adaptor LRT-57-001
F.	-	Pressure gauge LRT-57-005
G.	-	Thread adaptor LRT-57-004
H.	-	Thread adaptor LRT-57-022

1. **1.** A hydraulic pressure gauge and test adaptor is used to test the power steering system. This gauge is able to measure 140 kgf/cm². The maximum power steering system pressure is 77 kgf/cm².
2. **2.** Under certain fault conditions of the hydraulic pump it is possible to obtain pressures up to 105 kgf/cm². It is important to realise that pressure on gauge is same pressure being exerted upon steering wheel. When testing, turn steering wheel gradually while reading pressure gauge.
3. **3.** Check and maintain maximum fluid level of reservoir.
4. **4.** Examine power steering units and connections for leaks. All leaks must be rectified before attempting to test the system.
5. **5.** Check steering pump drive belt tension and renew belt if necessary.
6. **6.** Assemble test equipment and fit to vehicle, as shown in RR3959M.
7. **7.** Open tap of adaptor.
8. **8.** Bleed system, take care not to overload pressure gauge.
9. **9.** With system in good condition, pressures should be:
    1. (A) Steering wheel held on full lock and engine running at 1,000 rev/min, 70 to 77 kgf/cm².
    2. (B) Steering wheel held on full lock and engine idling, 28 kgf/cm².
    3. Checks should be carried out on both full lock positions.

CAUTION: Do not maintain this pressure for more than 30 seconds in any one minute to avoid overheating fluid and possibly damaging seals.

10. **10.** Release steering wheel and with engine idling. Pressure should read below 7 kgf/cm².
11. **11.** If pressures differ to those given a fault exists.
12. **12.** To determine if fault is steering box or pump. Close adaptor tap for a maximum five seconds.
13. **13.** If gauge does not register specified pressure, pump is faulty.
14. **14.** Fit a new pump, bleed system and repeat test. If low pressure on a substantial imbalance exists, fault is in steering box valve and worm assembly.

STEERING DAMPER

• NOTE: The power steering system, as well as reducing the effort required to manoeuvre the vehicle when parking, also helps to dampen any deflections of the road wheels, being transmitted back to the steering wheel.

When operating the vehicle off road, the road wheels are often deflected by ruts and boulders causing the steering wheel to turn left and right. This phenomenon is known as 'steering kickback'. To subdue the effects of 'steering kickback', a hydraulic damper is fitted in the steering linkage between the track rod and the differential casing. The damper, which offers the same resistance in extension and compression, is sealed for life.

1. **1.** Inspect damper for casing damage or leaks.
2. **2.** Clamp one end of the damper horizontally in a vice using soft jaws. Compress and extend the unit by hand. Resistance should be equal in both directions.
3. **3.** If it is felt that the unit is outside acceptable limits, fit a new steering damper.

VISUAL AND SAFETY CHECKS

WARNING: Before taking vehicle out on the public highway for road test, it is important that the following basic visual checks are carried out to ensure that the vehicle complies with legal requirements.

1. • NOTE: This information refers to standard tyres fitted as original equipment.

   1. Check and adjust tyre pressures.
2. **2.** Check condition of tyres. Inspect for signs of uneven wear, damage and feathering.
3. **3.** Check tread depth. Ensure that the tyre make, type and general condition are common across each axle.
4. **4.** Check wheel rims for signs of damage and excessive run out.

ROAD TEST PROCEDURE

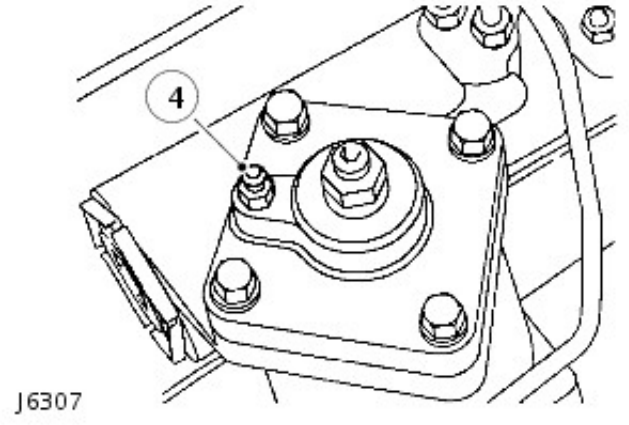
General steering/handling problems can usually be classified into one of the categories listed and ARE GENERALLY RELATED TO THE AGE, CONDITION AND USE OF THE VEHICLE.

WARNING: Ensure that all road tests are conducted by suitably qualified drivers in a safe and legal manner, and where local traffic conditions allow.

1. **1.** Carry out visual and safety checks.
2. **2.** Confirm general nature of complaint with customer, simulating where possible the conditions under which the problem occurs. Carry out following road test procedure to establish the problem.
3. **3.** Steering load assessment - drive at 16 km/h (10 mph). Put 90° turn input into steering wheel, check self centering. The self centering should be equal on each lock but not necessarily return to exactly straight ahead without assistance from the driver.
4. **4.** Steering assessment - drive at 64 km/h (40 mph) on a straight FLAT road (no camber), check for steering veer. The vehicle should follow a straight path with NO tendency to follow a curved path. If vehicle veers towards the kerb, vehicle may be 'camber sensitive'. A small amount of veer in direction of camber is acceptable.
5. **5.** Directional stability assessment - drive at 112 km/h (70 mph) or maximum legal speed on a straight flat road. Carry out a normal lane change. Vehicle should quickly settle into a new straight path.
6. **6.** Braking assessment (medium effort) - drive at 96 km/h (60 mph) on a straight flat road. Apply steady medium braking effort, noting any tendency to veer. Carry out brake test three times, if a veer is consistently noted carry out a braking efficiency test on a rolling road.
7. **7.** Braking assessment (full effort) - drive at 96 km/h (60 mph) on a straight flat road. Apply full braking effort, noting any tendency to veer. Carry out brake test three times, if a veer is consistently noted carry out a braking efficiency test on a rolling road.
8. **8.** If the symptom described by the customer is stiff steering or steering niggle, carry out stiff steering procedure. If not, proceed with basic checks and adjustments.

Steering System - General Information - Power Steering System Filling and Bleeding

General Procedures



1. Check that fluid level is at maximum level.
2. Run engine to normal operating temperature.
3. Recheck reservoir fluid level, top up if necessary.
4. NOTE: Maintain maximum fluid level in reservoir. Do not increase engine speed or move steering wheel.

   With engine at idle speed, slacken bleed screw. When fluid seeps past bleed screw re-tighten screw.
5. Check fluid level.
6. Clean fluid from around bleed screw.
7. Check hose connections, pump and steering box for fluid leaks by holding steering on full lock in both directions.

CAUTION: Do not maintain this pressure for more than 30 seconds in any one minute to avoid overheating fluid and possibly damaging seals.

8. Carry out road test.
9. Check and top-up fluid level.

Steering System - General Information - Power Steering System Flushing

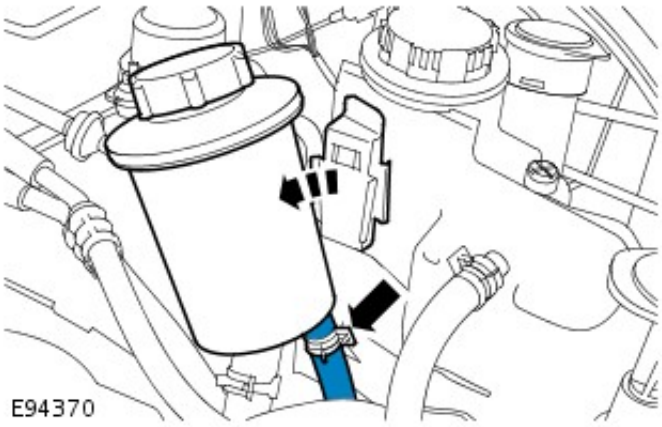
General Procedures

• NOTE: If heavy steering or contamination within the power steering system is found, it is necessary to carry out the system flush procedure as detailed below. If any components have been replaced in the power steering system the procedure below must be carried out in full.

• NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

1. Remove the power steering fluid reservoir cap.

2. Using a suitable syringe, remove the power steering fluid from the power steering fluid reservoir.

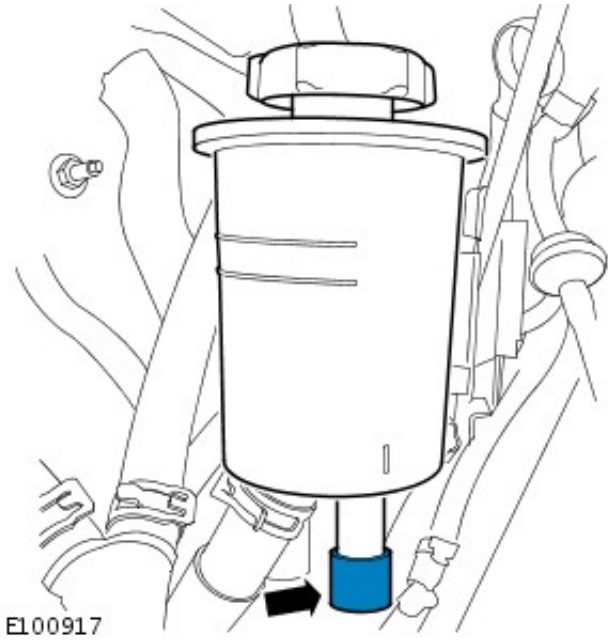


3. CAUTION: Be prepared to collect escaping fluids.

• NOTE: Note the orientation of the clip.

Detach the power steering fluid reservoir.

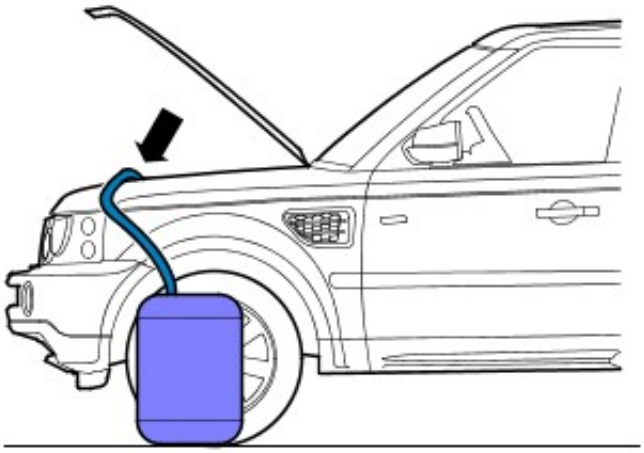
- Detach but do not remove the power steering fluid reservoir.
- Release the power steering fluid return hose from the power steering fluid reservoir.
- If a quick release coupling is fitted to the power steering return hose, release the power steering fluid return hose from the coupling by removing the clip.



4. CAUTION: Be prepared to collect escaping fluids.

• NOTE: Make sure that all openings are sealed. Use new blanking caps.

Using a suitable blanking cap, cap the power steering reservoir return pipe.



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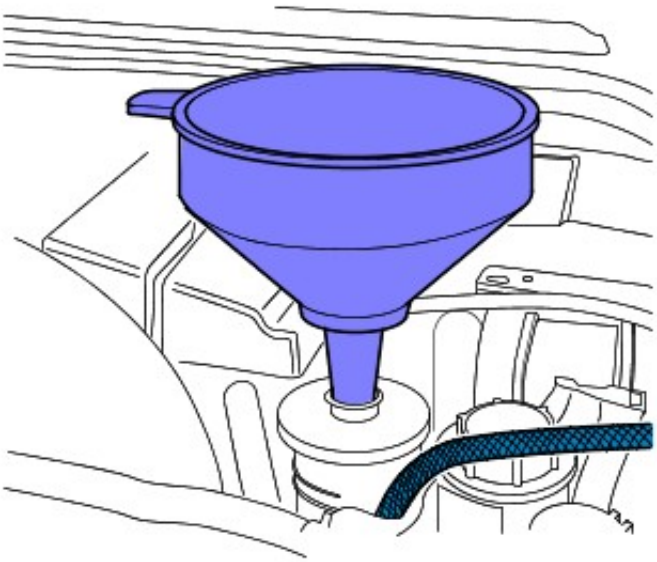
5. CAUTION: Be prepared to collect escaping fluids.

• NOTE: Make sure the extended pipe is not kinked or twisted and is correctly secured with hose clips.

Attach a suitable pipe to the power steering return hose to allow the fluid to drain.



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6. NOTE: The suitable funnel should have the a capacity of 4 litres and O-ring seal

• NOTE: The suitable funnel must be tightly sealed to the power steering fluid reservoir to avoid fluid leakage.

Install a suitable funnel onto the power steering fluid reservoir.

7. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle with the wheels just clear of the ground.

8. CAUTIONS:

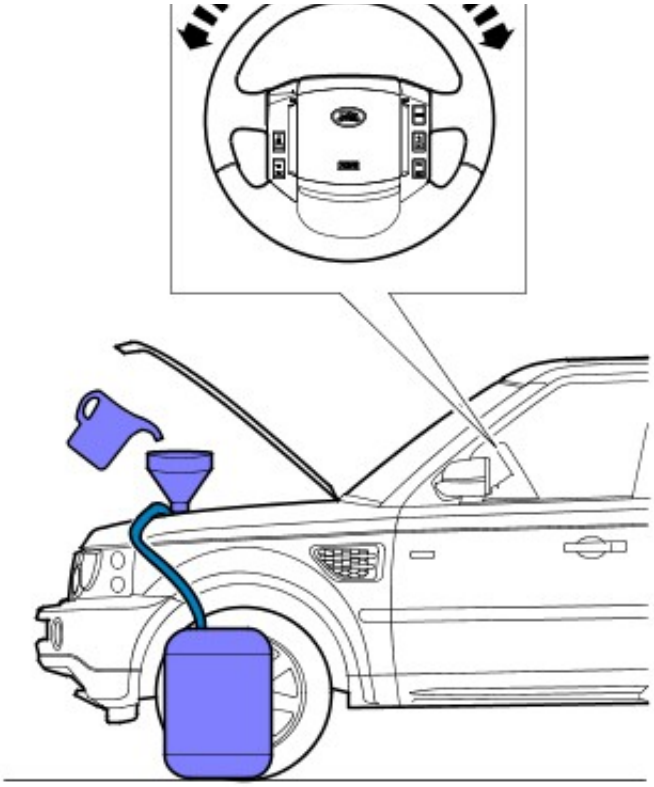
Steps 8 and 9 must be carried out within 2 - 3 seconds of each other. Failure to follow this instruction may result in damage to the power steering system.

Be prepared to collect escaping fluids.

Using the suitable funnel, top up the power steering system with the specified fluid. Make sure the fluid level is maintained at two thirds full in the funnel.

9. CAUTIONS:

Be prepared to collect escaping fluids.



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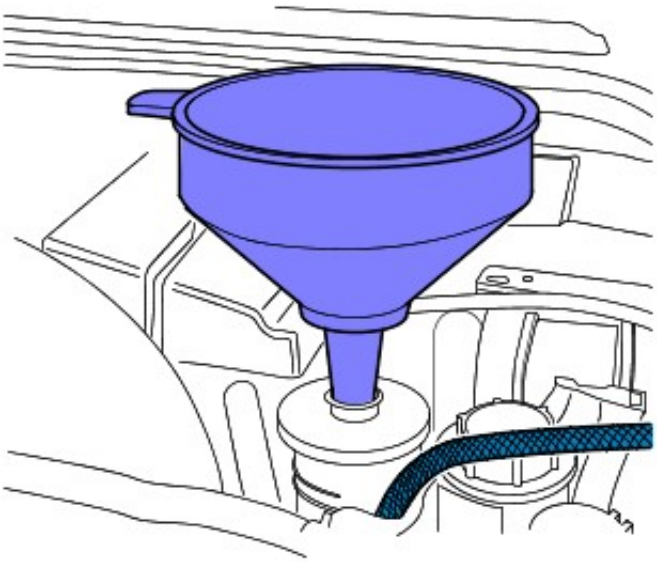
Do not allow the power steering fluid level in the power steering fluid reservoir to fall below the minimum power steering fluid level. Failure to follow this instruction may result in damage to the power steering system.

Make sure the engine is switched off as soon as the full 4 litres of power steering fluid has entered the power steering fluid reservoir.

Flush the power steering system.

- Start the engine
- With assistance turn the steering slowly lock to lock 3 times at approximately 1 revolution every 5 seconds.
- Continue to flush the power steering system until 4 litres of power steering fluid has been added to the power steering reservoir. This should take approximately 30 seconds.



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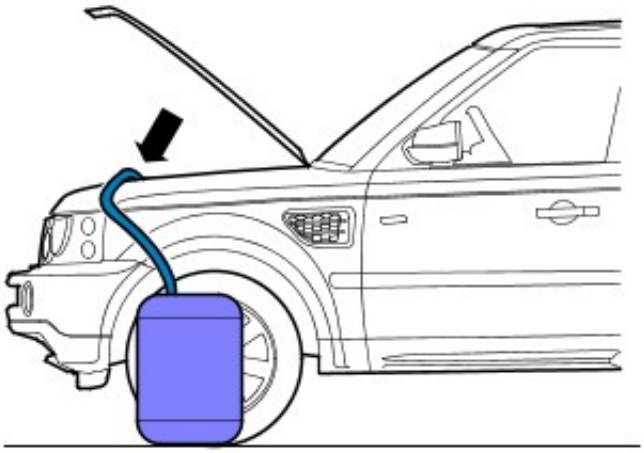
10. CAUTION: Be prepared to collect escaping fluids.

Remove the suitable funnel.

11. CAUTION: Be prepared to collect escaping fluids.

Remove the suitable pipe to the power steering return hose.



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12. CAUTION: Be prepared to collect escaping fluids.

- NOTE: Note the orientation of the clip.

If a quick release coupling is fitted to the power steering return hose, connect the power steering fluid return hose to the coupling by installing the clip.

13. Install a new power steering fluid reservoir.
For additional information, refer to: Power Steering Fluid Reservoir (211-02, Removal and Installation).

Steering System - General Information - Steering Gear Adjustment

General Procedures

1. WARNING: Adjustments of steering box should not be required while in warranty period. If box is stiff or tight and within warranty, it must be returned to manufacturer. No attempt must be made to introduce backlash.

Apply park brake, chock wheels and jack up front of vehicle until wheels are clear of ground.

2. Support chassis front on axle stands.

3. Disconnect drag link from steering drop arm.

4. Check torque to turn.
For additional information, refer to: Steering System (211-00 Steering System - General Information, Diagnosis and Testing).

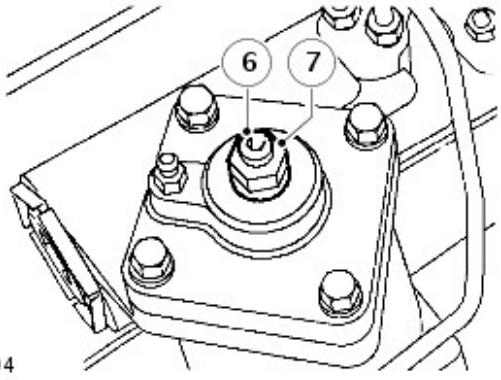
5. NOTE: Only check for no backlash when steering box is in central position.

• NOTE: If steering wheel is not straight, it should be repositioned
For additional information, refer to: Steering Wheel (211-04 Steering Column, Removal and Installation).

Centralise steering box.
For additional information, refer to: Steering Gear Centralization (211-00 Steering System - General Information, General Procedures).

6. Adjustment is obtained by rocking the drop arm about centre whilst an assistant slowly tightens the steering box adjuster screw.

7. Tighten locknut when all backlash has been removed.



8. Repeat the check for backlash. If backlash exists loosen locknut and repeat adjustment procedure.

9. Turn steering wheel lock to lock and check no tightness exists.

10. Ensure front wheels are aligned and in straight ahead position.

11. Adjust drag link 924 mm between ball joint centres.

12. Connect drag link and tighten to 40 Nm (30 lbf.ft).

13. Lower vehicle to ground level and remove chocks.

14. Road test vehicle
For additional information, refer to: Steering System (211-00 Steering System - General Information, Diagnosis and Testing).

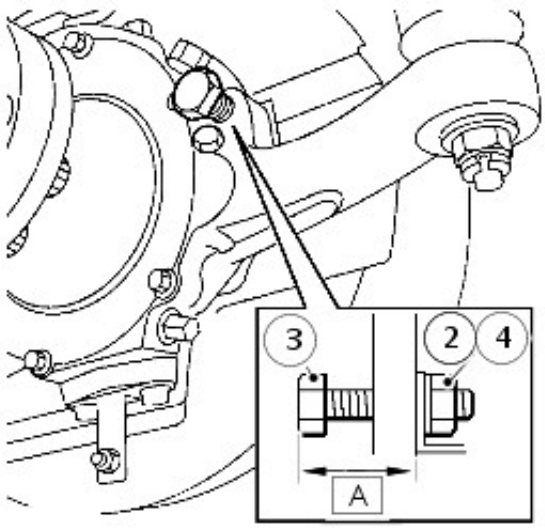
15. RH drive vehicles - if steering wheel is to right, drag link is too long. If steering wheel is to left drag link is too short. LH drive vehicles - if steering wheel is to right, drag link is too short. If steering wheel is to left drag link is too long.

16. Adjust drag link until steering wheel points straight ahead when vehicle is travelling in a straight line.

1. Disconnect sector shaft arm drag link from drop arm.
   For additional information, refer to: Sector Shaft Arm Drag Link (211-03 Steering Linkage, Removal and Installation).
2. Turn steering wheel on full RH lock.
3. Turn steering wheel back exactly two turns.
4. Fit sector shaft arm drag link.
   For additional information, refer to: Sector Shaft Arm Drag Link (211-03 Steering Linkage, Removal and Installation).
5. Repeat operation for LH drive vehicle but turn steering wheel on full LH lock.

Steering System - General Information - Steering Lock Stop Adjustment

General Procedures



J6295A

1. Measure clearance between tire wall and radius arm at full lock. This must be not less than 20 mm.
2. Loosen stop bolt locknut.
3. Turn stop bolt as required.
4. Tighten locknut.
5. Check clearance between tire wall and radius arm on each lock.
6. NOTE: Alternatively lock stop adjustment may be carried out using following procedure.

   Measure stop bolt protrusion 'A'. Refer to table for correct setting.

Alloys	Size	Setting
BF Goodrich Mud Terrain	265	59.7 mm
Goodyear GT+4	235	55.7 mm
Michelin M+S 4X4	235	52.2mm
Steels	**Size**	**Setting**
Goodyear	205	55.2 mm
Michelin	205	55.2 mm
Avon	7.50	56 mm
Michelin	7.50	56 mm
Goodyear	7.50	56 mm

7. Loosen stop bolt locknut.
8. Turn stop bolt as required.
9. Tighten locknut.
10. Check wheel position at full lock.

Power Steering -

Description	Nm	lb-ft
Power steering pump bolts	23	17
Power steering fluid reservoir nuts	4	3
Power steering high-pressure pipe union	20	15

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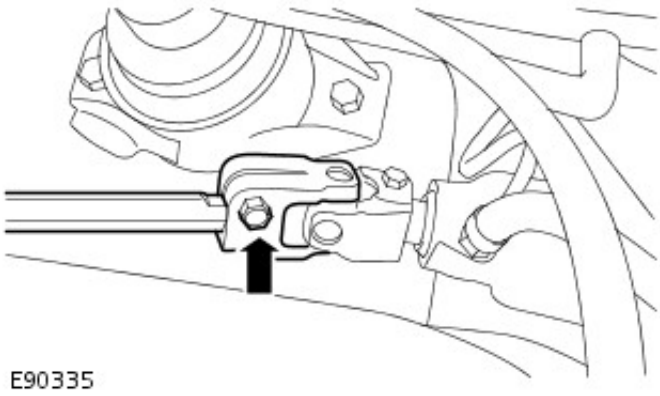
Power Steering - Steering Gear
Removal and Installation

Removal

1. Center the steering wheel.

- Lock in position, remove the ignition key.

2. Loosen the steering column lower shaft upper bolt.



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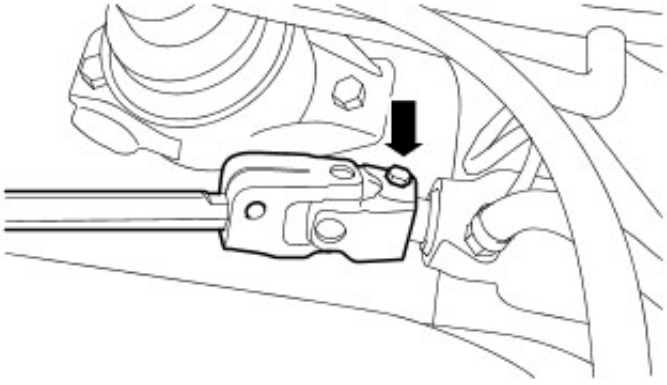
3. Release the steering column lower shaft from the steering gear.

- Remove the steering column lower shaft lower bolt.



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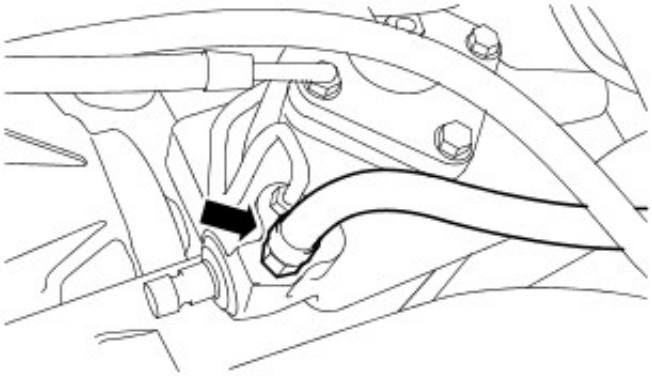
4. CAUTIONS:

If power steering fluid comes into contact with the paintwork, the affected area must be immediately washed down with cold water.

Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

Disconnect the power assisted steering (PAS) return hose from the steering gear.

- Position a suitable container to collect any power steering fluid spillage.



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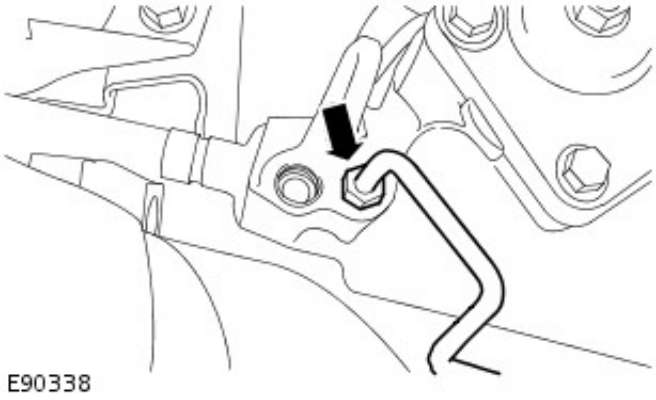
5. CAUTIONS:

5. CAUTIONS:


E90338

If power steering fluid comes into contact with the paintwork, the affected area must be immediately washed down with cold water.

Before disconnecting or removing the components, make sure the area around the joint faces and connections are clean. Plug open connections to prevent contamination.

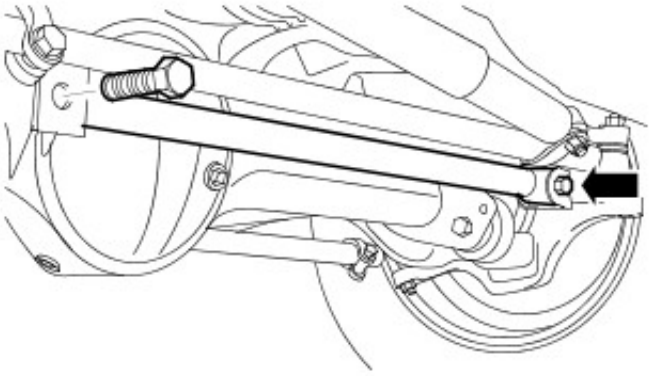
Disconnect the PAS feed pipe from the steering gear.

6. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

7. Remove the panhard rod.

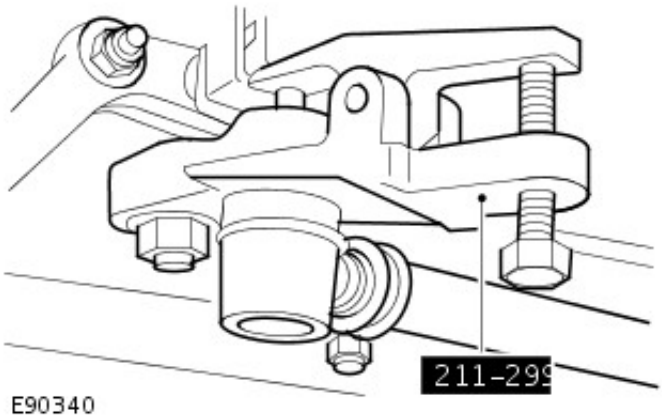
- Remove the 2 panhard rod nuts and bolts.
- Discard the 2 panhard rod nuts.


E90339

8. CAUTION: Make sure the ball joint seal is not damaged. A damaged seal will lead to the premature failure of the joint.

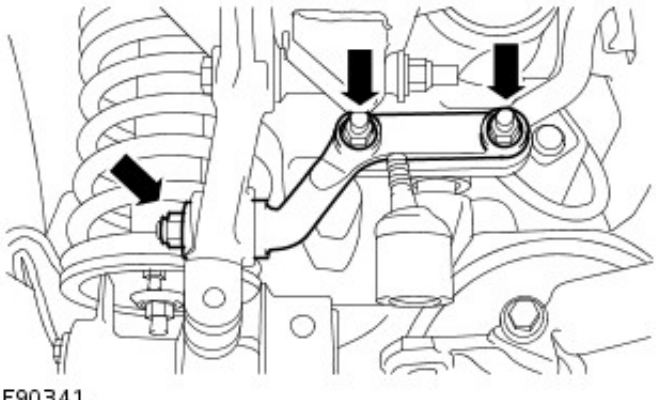
Using the special tool, release the drag link from the drop arm.

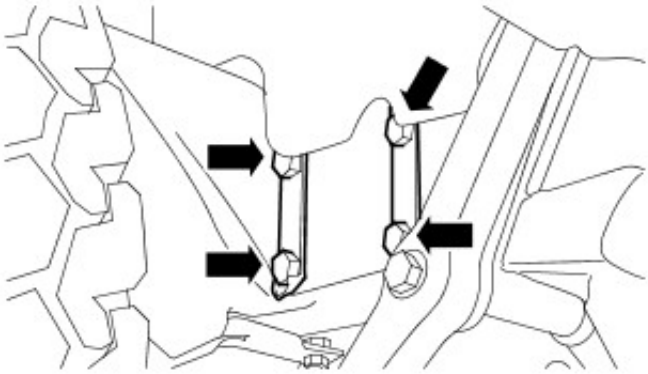
- Remove the split pin.
- Remove the drag link to drop arm nut.



E90340

9. Remove the tie bar.


E90341



E90342

10. With assistance, remove the steering gear.

- Release the 2 tab washers.
- Remove and discard the 4 steering gear bolts.
- Remove and discard the 2 tab washers.

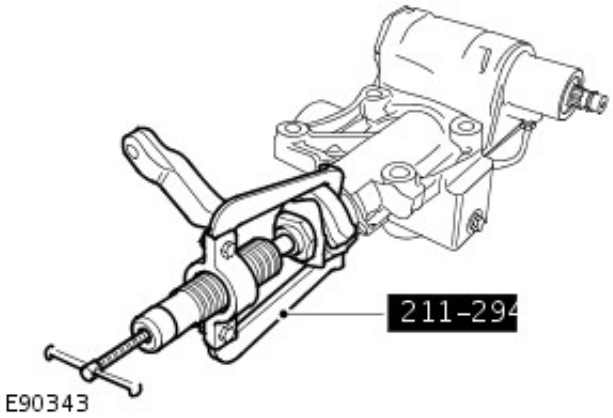
11. NOTE: When installing a reconditioned steering gear, complete steps 12, 13 and 14.

Release the drop arm nut lock washer.

12. Remove and discard the drop arm nut.

- Discard the drop arm nut lock washer.

13. Using the special tool, remove the drop arm from the steering gear.



E90343

Installation

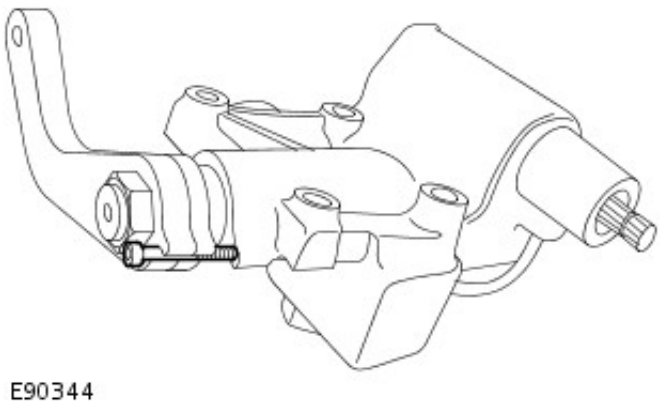
1. Clean the drop arm and steering gear mating faces.

2. NOTE: Install a new nut and lock washer.

Install the drop arm to the steering gear.

- Install the lock washer.
- Install but do not fully tighten the drop arm nut.

3. Install the centralizing bolt to the steering gear.



E90344

4. Secure the drop arm in a suitable vice.

5. Tighten the drop arm nut to 176 Nm (130 lb.ft).

6. Secure the drop arm nut using the lock washer.

7. Remove the steering gear assembly from the vice.

8. NOTE: Install new bolts and tab washers.

With assistance, install the steering gear.

- Install the tab washers.
- Install the steering gear bolts and tighten to 65 Nm (48 lb.ft).

9. Secure the steering gear bolts using the tab washers.

10. Install the tie bar to the steering gear.

- Loosely install the nuts and bolts.

11. Tighten the tie bar to panhard rod mount bracket nut to 83 Nm (61 lb.ft).

12. Tighten the tie bar to steering gear nuts and bolts to 85 Nm (63 lb.ft).

13. Secure the drag link to the drop arm.

- Install the nut and tighten to 40 Nm (30 lb.ft).
- Install the split pin.

14. NOTE: Install new nuts.

Install the panhard rod.

- Tighten the nuts and bolts to 230 Nm (178 lb.ft).

15. CAUTION: If power steering fluid comes into contact with the paintwork, the affected area must be immediately washed down with cold water.

• NOTE: Inspect the O-ring seal, if there is any indication of damage install a new seal.

Connect the PAS feed pipe to the steering gear.

- Tighten to 20 Nm (15 lb.ft).

16. CAUTION: If power steering fluid comes into contact with the paintwork, the affected area must be immediately washed down with cold water.

• NOTE: Inspect the O-ring seal, if there is any indication of damage install a new seal.

Connect the PAS return hose to the steering gear.

- Tighten to 15 Nm (11 lb.ft).

17. Check the alignment and install the steering column lower shaft to the steering gear.

- Install the steering column lower shaft lower bolt and tighten to 22 Nm (16 lb.ft).

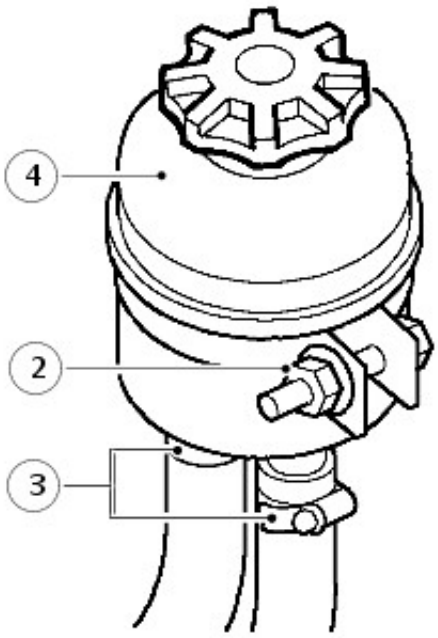
18. Tighten the steering column lower shaft upper bolt to 22 Nm (16 lb.ft).

19. Remove the centralizing bolt from the steering gear.

20. Refill and bleed the PAS system.
For additional information, refer to: Power Steering System Filling and Bleeding (211-00 Steering System - General Information, General Procedures).

Power Steering - Power Steering Fluid Reservoir

Removal and Installation



J6308

Removal

1. Position drain tin beneath reservoir.
2. Slacken mounting bracket clamp bolt and raise reservoir to gain access to feed and return hose retaining clips.
3. Slacken clips, disconnect hoses from reservoir, allow fluid to drain.
4. CAUTION: Plug connections to prevent ingress of dirt.

   Discard fluid drained from system. Do not allow fluid to contact paintwork, if spilled, remove fluid and clean area with warm water.

   Remove reservoir.

Installation

1. Position reservoir, connect feed and return hoses and tighten clips to 3 Nm (2 lbf/ft).
2. Fit reservoir in clamp, tighten clamp bolt.
3. Fill reservoir between upper mark and end of dipstick with power steering fluid.
   For additional information, refer to: Specifications (211-00 Steering System - General Information, Specifications).
4. Bleed power steering system.
   For additional information, refer to: Power Steering System Filling and Bleeding (211-00 Steering System - General Information, General Procedures).

Power Steering - Power Steering Pump
Removal and Installation

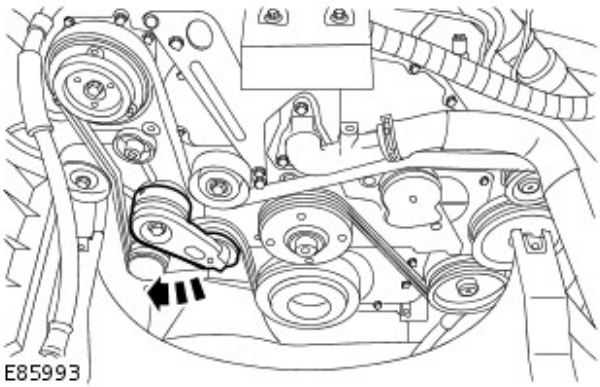
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the cooling fan.
For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Release the tension from the accessory drive belt.

- Rotate the accessory drive belt tensioner clockwise.



4. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

5. CAUTIONS:

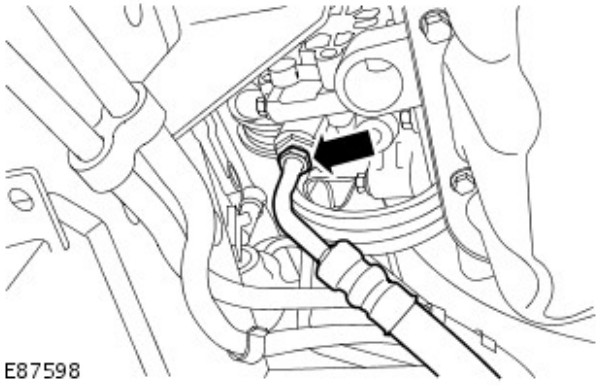
Make sure that the area around the component is clean and free of foreign material.

Make sure that all openings are sealed. Use new blanking caps.

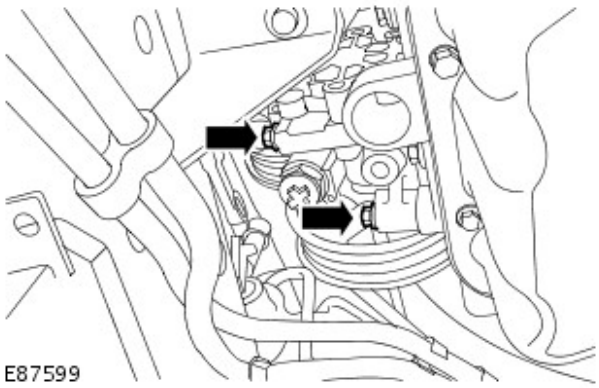
If power steering fluid comes into contact with the paintwork, the affected area must be immediately washed down with cold water.

Disconnect the power steering high-pressure pipe union.

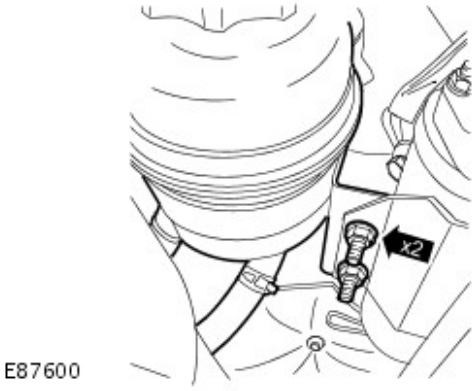
- Remove and discard the O-ring seal.



6. Remove the 2 bolts from the power steering pump.

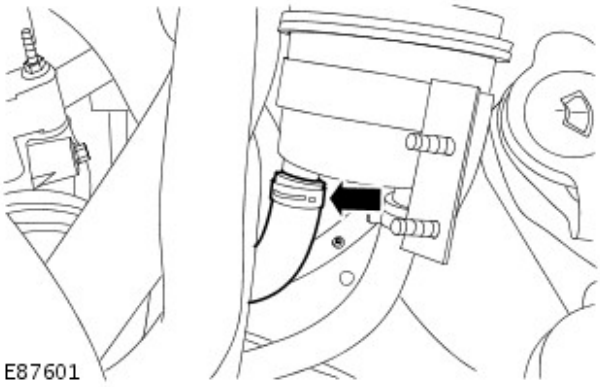


7. Release the power steering fluid reservoir.



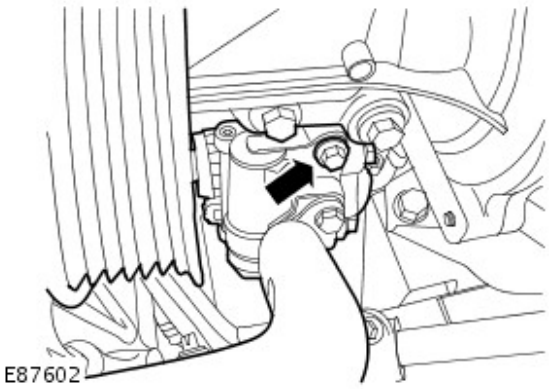
- Remove the 2 nuts.

8. Disconnect the power steering fluid reservoir supply hose.



- Release the clip.

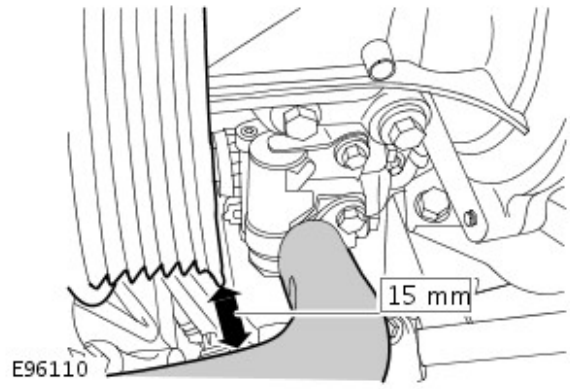
9. Remove the power steering pump.



- Remove the bolt.

Installation

1. Install the power steering pump.



- Tighten to 23 Nm (17 lb.ft).

2. CAUTION: A 15 mm gap, or greater, must exist between the power steering pump pulley and the hose, at the rearmost edge of the pulley. Adjust the hose if required.

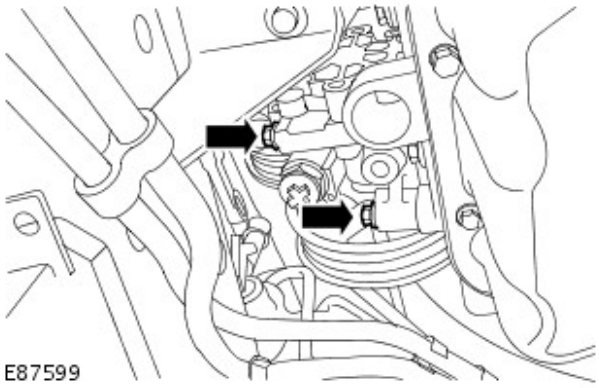
Connect the power steering fluid reservoir supply hose.

- Secure the clip.
- Check that the correct gap exists between the power steering pump pulley and the hose.

3. Secure the power steering fluid reservoir.

- Tighten to 4 Nm (3 lb.ft).

4. Tighten to 23 Nm (17 lb.ft).

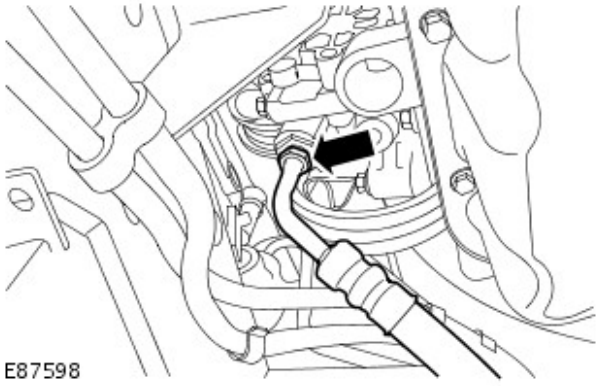


5. NOTE: Remove and discard the blanking caps.

• NOTE: Install a new O-ring seal.

Connect the power steering high-pressure pipe union.

- Tighten to 20 Nm (15 lb.ft).



6. Secure the accessory drive belt.

- Rotate the accessory drive belt tensioner clockwise.

7. Install the cooling fan.
For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

8. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

9. Fill and bleed the power steering system.
For additional information, refer to: Power Steering System Filling and Bleeding (211-00 Steering System - General Information, General Procedures).

Power Steering - Steering Gear

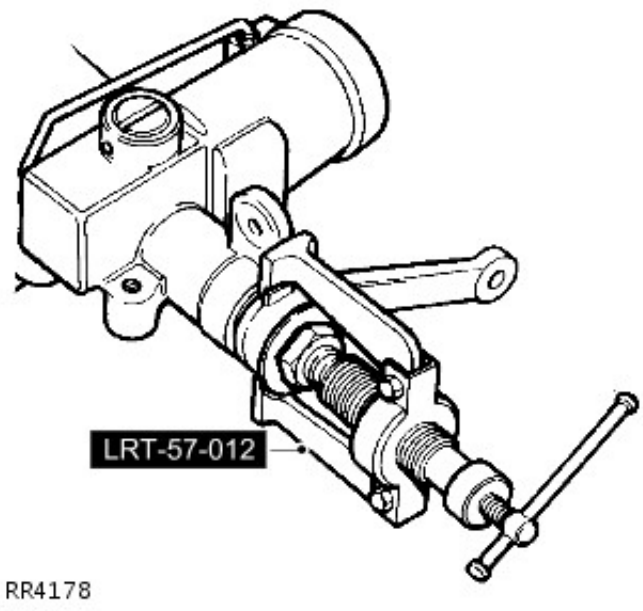
Disassembly and Assembly

Disassembly

WARNING: Wear safety glasses while removing and refitting circlips and retaining ring.

CAUTION: Absolute cleanliness is essential when overhauling steering gear.

- NOTE: Overhaul of steering gear should not be carried out during the warranty period.
- NOTE: This procedure is for Adwest steering gear only.



RR4178

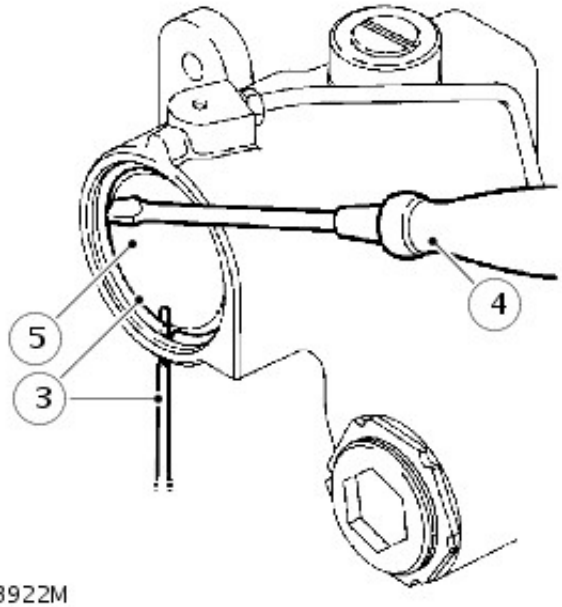
1. Remove steering gear from vehicle.
For additional information, refer to: Steering Gear (211-02 Power Steering, Removal and Installation).
Mark drop arm and steering gear for realignment on assembly. Remove drop arm using extractor LRT-57-012. Loosen drop arm securing nut, but do not remove before using extractor. Remove dirt excluder from output shaft.

2. Drain oil, remove blanking plugs and bleed screw. Hold steering gear over suitable container, turn input shaft from lock to lock, until oil is drained. Refit bleed screw.

3. Rotate retainer ring until one end is 12 mm from extractor hole. Using a drift through hole in cylinder, lift retaining ring from groove in cylinder bore.

4. Remove retainer ring, using a screwdriver.

5. Turn input shaft (left lock on left hand drive vehicles, right lock on right hand drive vehicles) until piston pushes out cover. Turn input shaft fully in opposite direction, applying pressure to piston.



RR3922M

6. Remove set screw retaining rack pad adjuster.

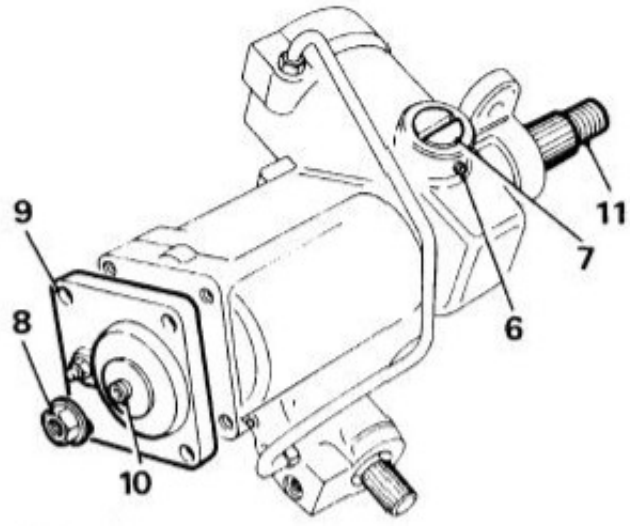
7. Remove rack adjuster and pad.

8. Remove sector shaft adjuster locknut.

9. Remove four bolts from sector shaft cover.

10. Screw in sector shaft adjuster until cover is removed.

11. Slide out sector shaft.



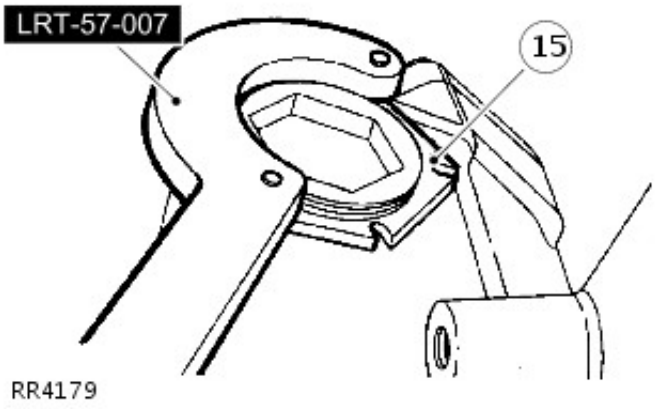
RR924N

12. Remove piston, a bolt screwed into piston will assist removal.

13. Remove input shaft dirt excluder.

14. Remove worm adjuster locknut using 'C' wrench LRT-57-007.

15. Remove worm adjuster using wrench LRT-57-006.



RR4179

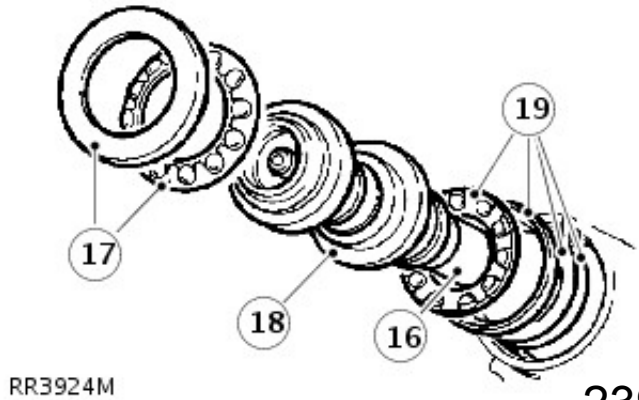
16. Tap splined end of shaft to free bearing.

17. Remove bearing cup and caged ball bearing assembly.

18. Remove valve and worm assembly.

19. NOTE: If difficulty is experienced warm the casing and bearing assembly. Cool bearing cup using a mandrel and tap steering gear on a bench.

Remove inner bearing cage, cup and shim washers. Retain shims for reassembly.



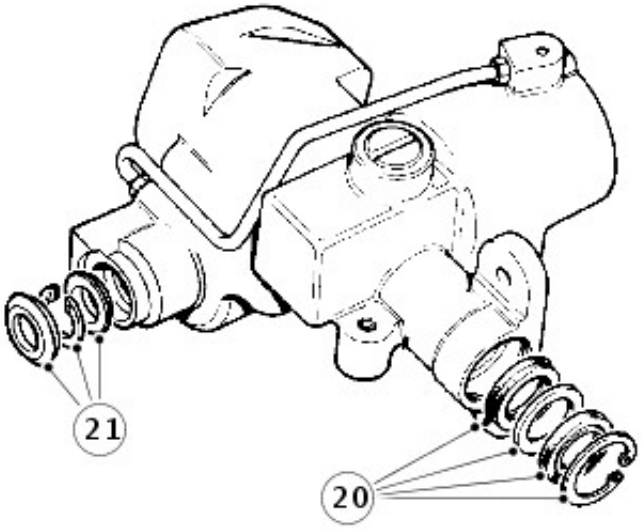
RR3924M

20. CAUTION: Do not remove sector shaft bearings from casing. Replacement parts are not available. If sector shaft bearings are worn fit a new steering gear.

Remove circlip and seal from sector shaft housing bore.

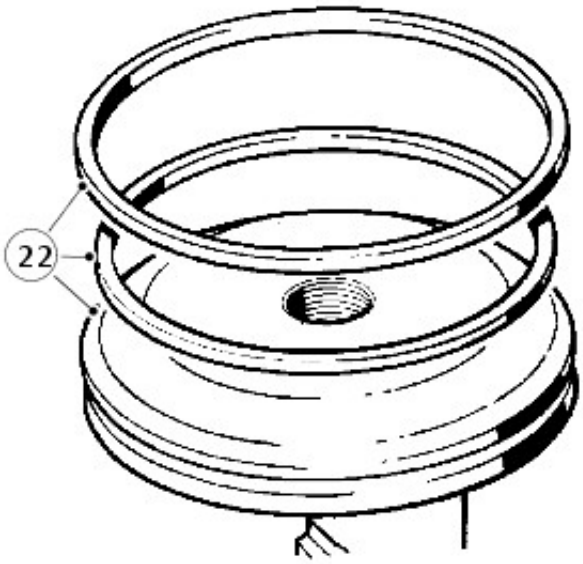
21. CAUTION: The use of a seal puller is recommended to prevent damage to casing, resulting in possible oil leaks.

Remove dirt excluder, circlip and seal from input shaft housing bore.



RR4180

22. Discard all rubber seals and obtain replacements.



RR2350E

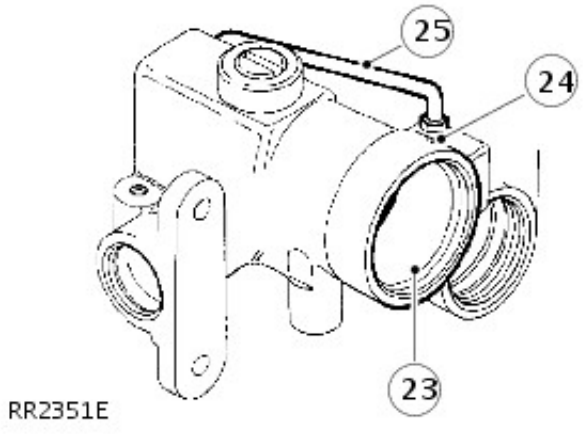
- NOTE: A rubber seal is fitted behind plastic ring on rack piston. Discard seal and plastic ring.

23. Examine piston bore for scoring and wear.

24. Examine feed tube.

25. Fit a new feed tube if damaged. Tighten union to 22 Nm

(16 lbf/ft).



RR2351E

26. Check there is no side play on roller.

27. If side play on roller exists fit a new sector shaft.

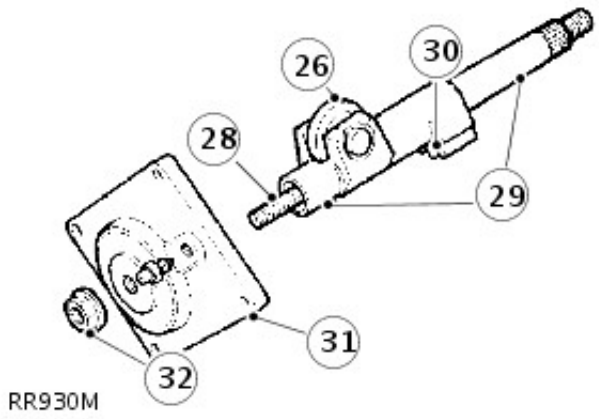
28. Check condition of adjuster screw threads. Check adjuster end float. Fit new adjuster if end float exceeds 0.15 mm.

29. Examine bearing areas on shaft for excessive wear.

30. Examine gear teeth for uneven or excessive wear.

31. Inspect cover and bearing. If worn or damaged, fit a new steering gear.

32. The locknut is also a fluid seal. Fit new nut during assembly.



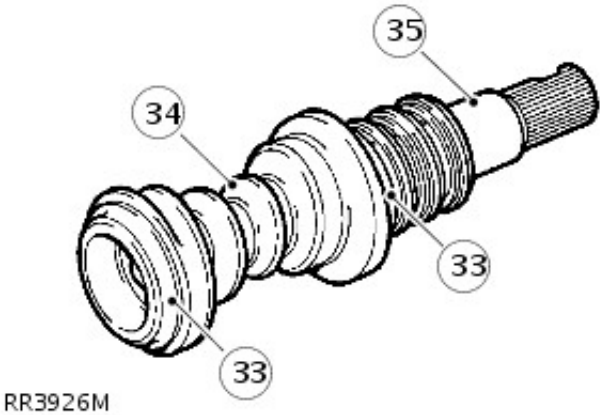
RR930M

33. Examine bearing areas for wear. The areas must be smooth and not indented.

34. Examine worm track which must be smooth and not indented.

35. NOTE: Any sign of wear makes it essential to fit new valve and worm assembly.

Check for wear on torsion bar assembly pin. No free movement should exist between input shaft and torsion bar or between torsion bar and worm.



RR3926M

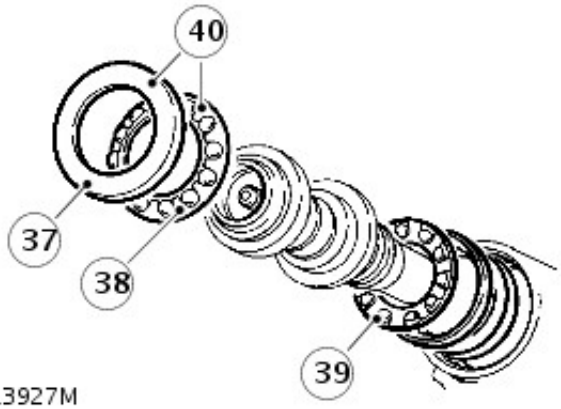
36. Examine valve rings for cuts , scratches and grooves. The valve rings should be free to rotate in grooves. Renew the valve and worm assembly if any faults are found.

37. Examine ball races and cups for wear and general condition.

38. If ball cage has worn against bearing cup, fit replacements.

39. Bearing balls must be retained by cage.

40. Bearing and cage repair is carried out by complete replacement of assembly.

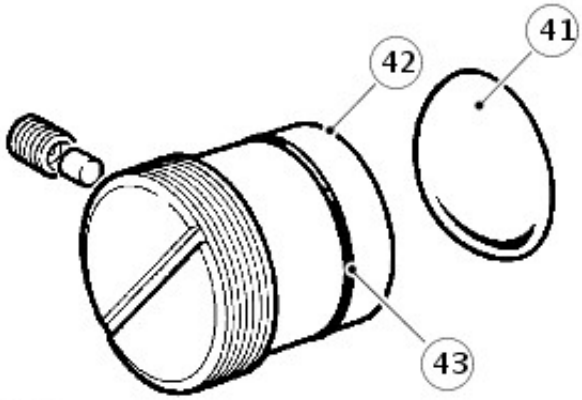


RR3927M

41. Examine thrust pad for scores.

42. Examine adjuster for wear in pad seat.

43. Fit new sealing ring to rack adjuster.



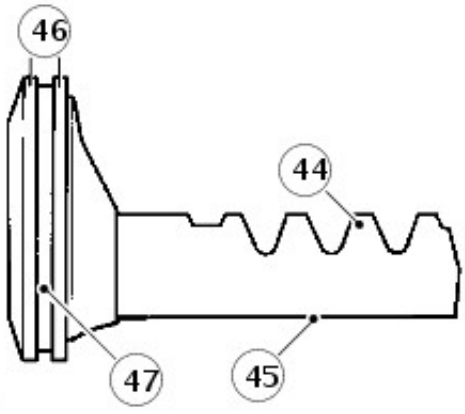
RR3928M

44. Examine for excessive wear on rack teeth.

45. Ensure thrust pad bearing surface is free from scores and wear.

46. Ensure piston outer diameters are free from burrs and damage.

47. Examine seal and ring groove for scores and damage.



RR3929M

Assembly

1. Fit new ring to piston. Warm nylon seal and fit to piston.

2. Slide piston assembly into cylinder with rack tube outwards.

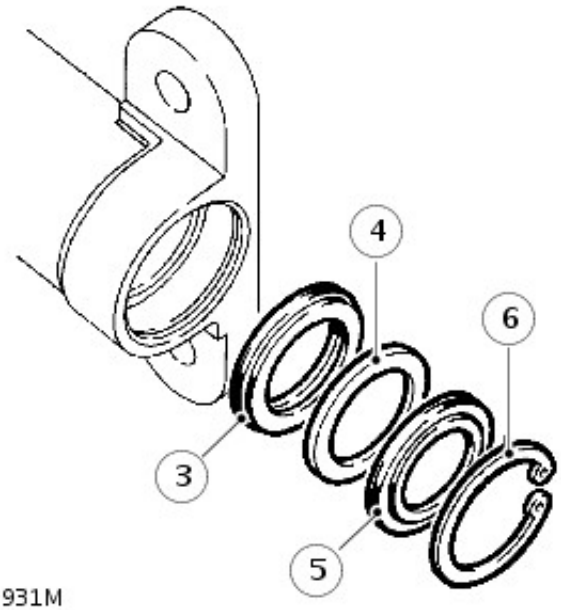
• NOTE: When fitting replacement oil seals lubricate with recommended fluid and ensure absolute cleanliness.

3. Fit oil seal, lip side first.

4. Fit extrusion washer.

5. Fit dust seal, lipped side last.

6. Fit circlip.



RR3931M

7. Refit original shims and inner bearing cup. Use Petroleum Jelly to aid assembly.

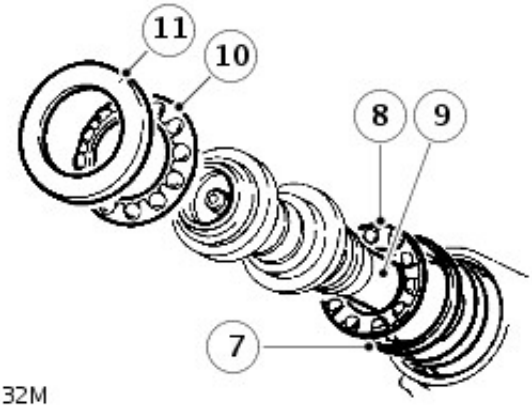
• NOTE: If original shims are not used, fit shims of 0.76 mm thickness.

8. Fit inner cage and bearings assembly.

9. Fit valve and worm assembly.

10. Fit outer cage and bearings assembly.

11. Fit outer bearing cup.



RR3932M

12. Fit new worm adjuster sealing ring.

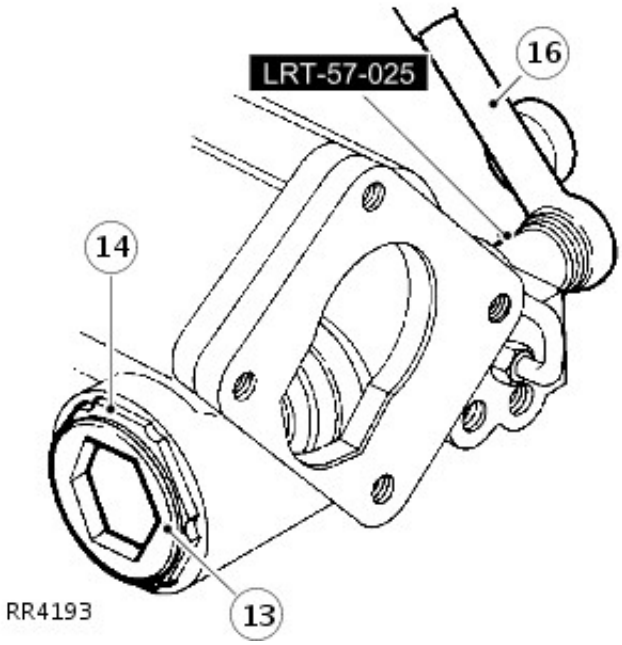
13. Loosely screw adjuster into casing.

14. Fit locknut, do not tighten.

15. Turn in worm adjuster until end float is almost eliminated. Ensure bearing cages are seated correctly.

16. Measure maximum rolling torque of valve and worm

assembly, using a torque wrench and spline socket LRT-57-025.



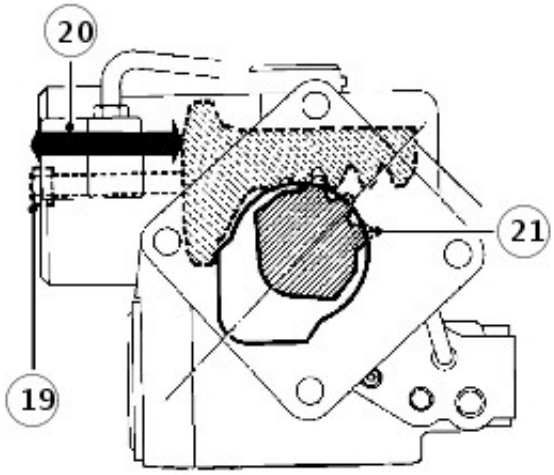
17. Turn in worm adjuster while rotating shaft to increase figure measured to 0.56 Nm.

18. Back off worm adjuster ¼ turn. Turn in worm adjuster to increase reading by 0.21 - 0.34 Nm with locknut tight, 100 Nm (74 lbf/ft). Use worm adjusting wrench LRT-57-006 and locknut wrench LRT-57-028.

19. Screw slave bolt into piston to aid assembly.

20. Fit piston and rack so piston is 70 mm (2.75 in) from outer end of bore.

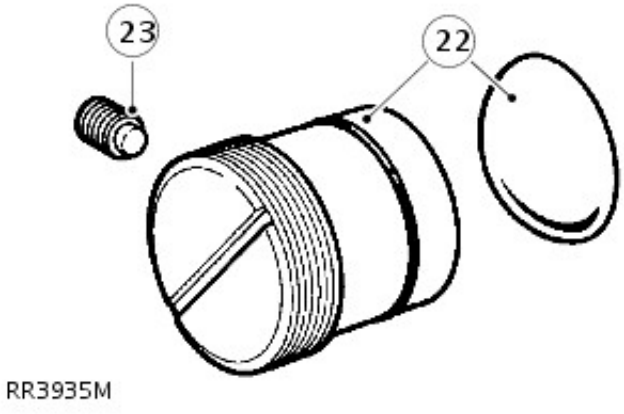
21. Fit sector shaft using seal saver LRT-57-021. Align roller with cut out in casing as shown. Push in sector shaft while rotating input shaft to allow sector roller to engage worm.



22. Fit rack adjuster and thrust pad to engage rack. Back off half turn on adjuster.

23. Loosely fit new nylon pad and adjuster set screw

assembly.



24. Fit new sealing ring to cover.

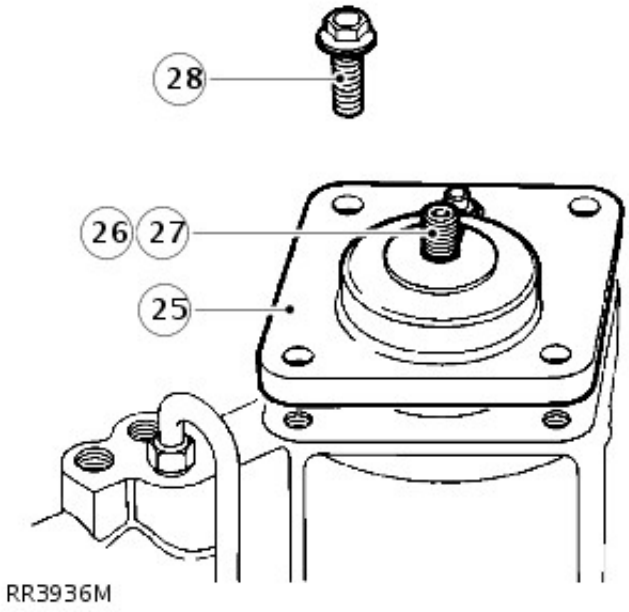
25. Align cover with casing.

26. Screw cover assembly fully on to sector shaft adjuster screw.

27. If necessary back off sector shaft adjuster screw. Tap cover in place to allow cover to joint fully with casing.

• NOTE: Before tightening fixings, rotate input shaft to ensure sector shaft roller is free to move in valve worm. If initial resistance is left, turn adjuster screw approximately two turns in a clockwise direction.

28. Fit cover bolts. Tighten to 75 Nm (55 lbf/ft).

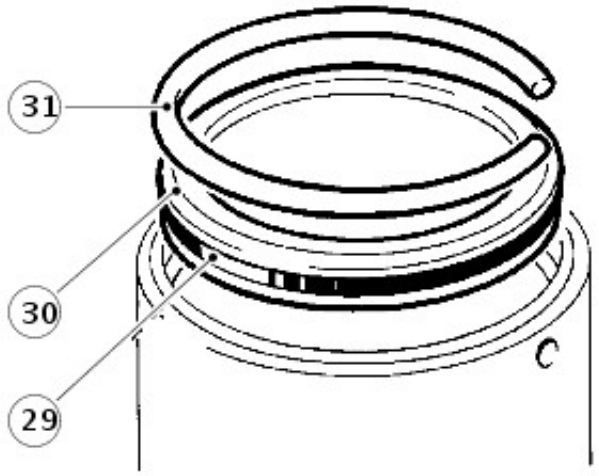


29. Fit new square section seal to cover.

30. Remove slave bolt from piston. Press cover into cylinder just to clear retainer ring groove.

31. Fit retaining ring to groove with one end of ring

positioned 12 mm from extractor hole.



RR3937M

32. Refit drop arm and tighten nut sufficiently to ensure that no backlash exists between drop arm and sector shaft.

33. To set worm on centre, rotate input shaft to full inner-lock (full right lock for a left hand drive vehicles, full left lock for a right hand drive vehicles). Rotate input shaft back towards centre two full turns.

34. The box is now on centre and can be adjusted.

35. Hold input shaft and rock the drop arm to establish backlash is present. Continue rocking and slowly turn sector shaft adjusting screw clockwise. Continue turning adjuster screw until backlash has almost been eliminated.

36. Refit locknut and tighten.

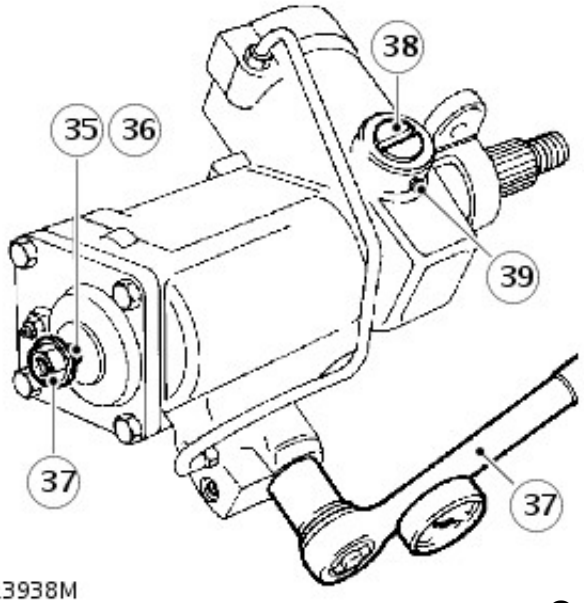
• NOTE: It is important steering gear is centralised before any adjustments are made.

37. Check maximum rolling torque one and a quarter turns either side of centre position, using a torque wrench and spline socket LRT-57-025. Rotate adjuster screw to obtain across centre torque of 0.34 Nm plus torque figure at one and a quarter turns. Tighten adjuster locknut to 60 Nm (44 lbf/ft).

38. Turn in rack adjuster to increase figure measured in previous instruction by 0.23 - 0.34 Nm. **The final figure may be less, but must not exceed 1.35 Nm.**

39. Lock rack adjuster in position with grub screw. Tighten to 5 Nm (4 lbf/ft).

1. With input shaft rotated from lock to lock, rolling torque figures should be greatest across centre position and equally disposed about centre position.
2. The condition depends on the value of the shimming fitted between the valve and worm assembly inner bearing cup and casing. The original shim value will give correct torque peak position unless major components have been replaced.



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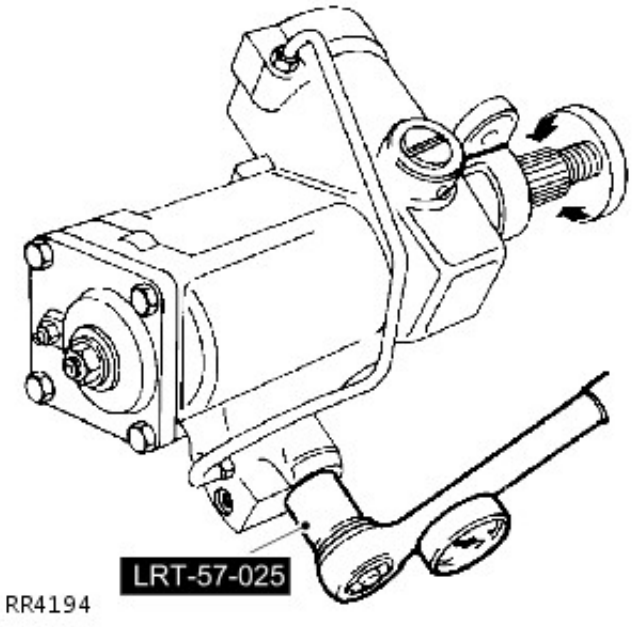


40. With input coupling shaft toward the operator, turn shaft fully anti-clockwise.

41. Check torque figures obtained from lock to lock using torque wrench and spline socket LRT-57-025.

42. Check also for equal engagement either side of centre.

43. Note where greatest figures are recorded relative to steering position. If greatest figures are not recorded across centre of travel (steering straight-ahead), adjust as follows:

1. If torque peak occurs **before** centre position, **add** to shim washer value.
2. If torque peak occurs **after** centre position, **subtract** from shim washer value.
3. Shims are available in the following thicknesses; 0.03 mm, 0.07 mm, 0.12 mm and 0.24 mm.

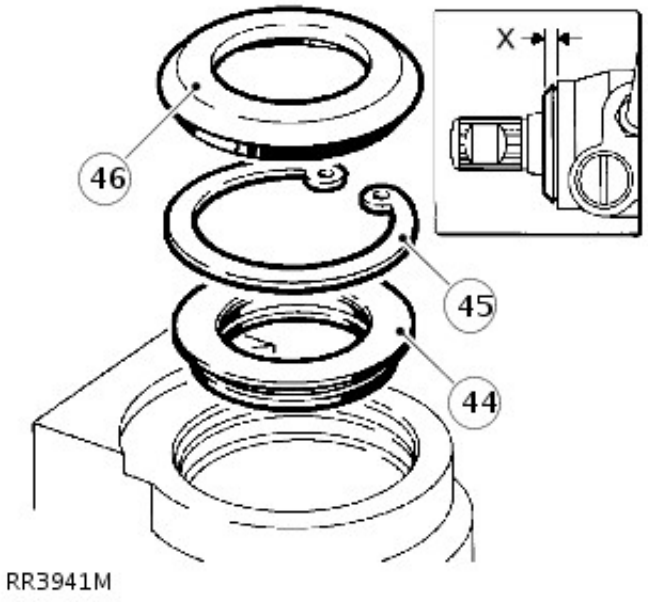
⚠CAUTION: When reshimming valve and worm, extreme caution must be exercised to prevent seal damage during reassembly.

• NOTE: Adjustment of 0.07mm to shim value will move torque peak area by ¼ turn on the shaft.

44. Fit seal, lip side first, into housing. Use seal saver LRT-57-016 and seal installer LRT-57-026. Note that seal is fitted to a depth of 4.75 - 5.00 mm from face of box.

45. Secure seal with circlip.

46. Smear inner lip of dirt excluder with PTFE grease. Fit dirt



excluder using LRT-57-027. When fitted correctly outer shoulder of excluder is 4.00 - 4.50 mm from face of box, dimension X.

47. Remove drop arm. Smear inner lip of dirt excluder with PTFE grease and refit, ensuring outer lip is flush with casing.

48. With input shaft on centre, align assembly marks on drop arm and steering gear. Fit drop arm to steering gear using a new tab washer. Tighten to 176 Nm (130 lbf/ft), bend over tab.

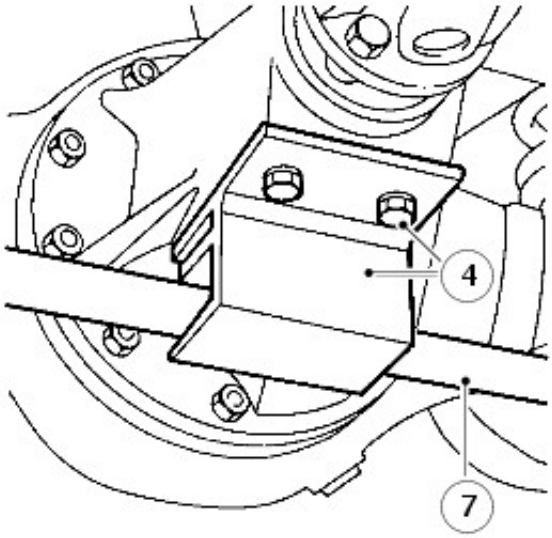
49. Fit steering gear.
For additional information, refer to: Steering Gear (211-02 Power Steering, Removal and Installation).

Steering Linkage - Tie Rod End

Removal and Installation

Removal

1. Park vehicle on level ground and chock rear wheels.
2. Raise vehicle and locate axle stands or use a ramp.
3. Centralise steering.
   For additional information, refer to: Steering Gear Centralization (211-00 Steering System - General Information, General Procedures).
4. Unscrew 2 bolts and remove tie rod protection bracket from axle differential housing.
5. Remove split pin and castellated nut securing tie rod to swivel housing arms.
6. Disconnect tie rod ends using LRT-57-018.



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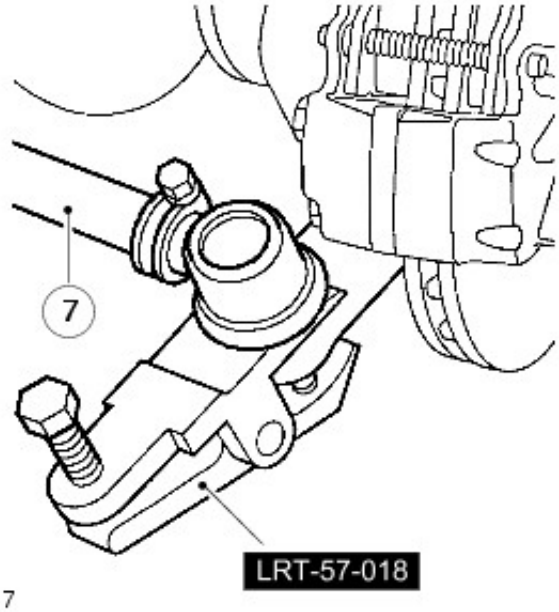
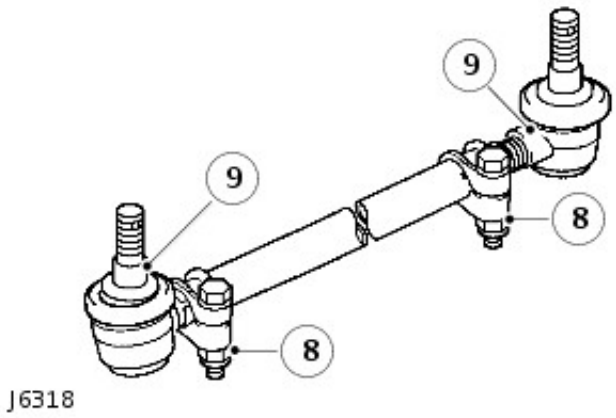
7. Remove tie rod.



J6317

8. Slacken clamp bolts.
9. Unscrew tie rod ends.



Installation

1. Fit new tie rod ends to tie rod and loosely tighten clamp bolts.
2. Screw in tie rod ends to full extent of threads and fully tighten clamp bolts.

CAUTION: A tie rod that is damaged or bent must be renewed. DO NOT attempt to repair or straighten it.

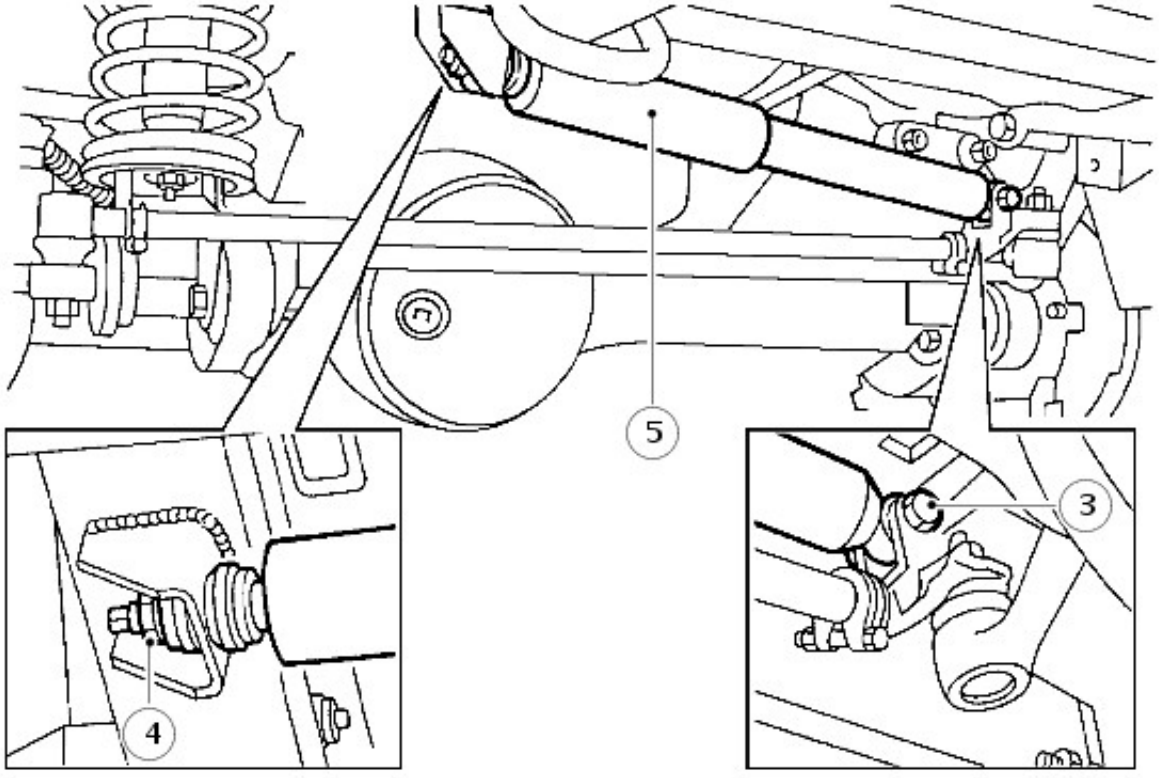
3. Fit tie rod to swivel housing arms and tighten tie rod end nuts to 44 Nm (32 lbf/ft). Fit new split pin.
4. Fit tie rod protection bracket to axle differential housing and tighten to 30 Nm (22 lbf/ft).
5. Check wheel alignment.
   For additional information, refer to: Front Toe Adjustment (204-00 Suspension System - General Information, General Procedures).
6. Remove axle stands or vehicle from ramp.

Steering Linkage - Steering Linkage Damper

Removal and Installation

Removal

1. Park vehicle on level ground and chock rear wheels.
2. Raise vehicle and locate axle stands or use a ramp.
3. Remove bolt securing steering linkage damper to drag link bracket.
4. Remove retaining nuts, washers and rubber bush securing steering linkage damper to chassis mounting.
5. Withdraw steering linkage damper.



J6315

6. Check rubber bushes and washers, renew if necessary.

Installation

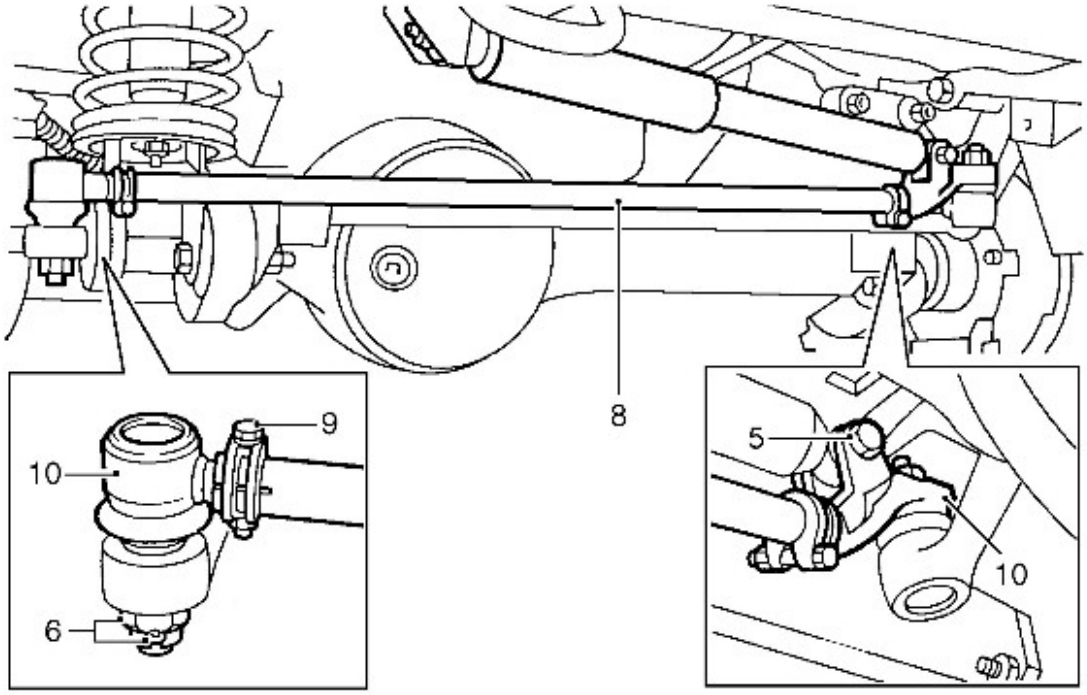
1. Ensuring rubber bushes and washers are correctly positioned, fit steering linkage damper to chassis mounting.
2. Instal steering linkage damper to drag link bracket.
3. Remove axle stands or vehicle from ramp.

Steering Linkage - Sector Shaft Arm Drag Link

Removal and Installation

Removal

1. Park vehicle on level ground and chock rear wheels.
2. Set road wheels in straight ahead position.
3. Raise vehicle and fit axle stands or use a ramp.
4. Remove front road wheel.
5. Disconnect steering damper at sector shaft arm drag link bracket.
6. Remove split pin and castellated nut securing sector shaft arm drag link ball joint to swivel housing arm.
7. Disconnect sector shaft arm drag link ball joints using LRT-57-018.
8. Remove sector shaft arm drag link.
9. Slacken clamp bolts.
10. Unscrew ball joints and remove from sector shaft arm drag link.

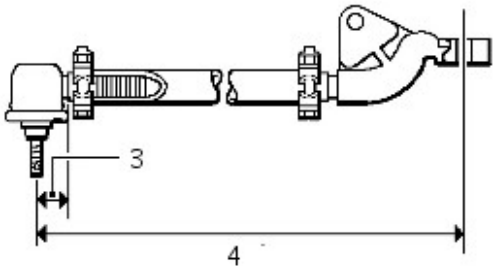


J6319

Installation

1. Clean internal threads of sector shaft arm drag link.
2. Fit new ends to sector shaft arm drag link and loosely fit clamp bolts.
3. Set ball joints to sector shaft arm drag link measurement to 28,5 mm.
4. Adjust ball pin centres to nominal length of 924 mm, this

length is adjusted during refit.



J6320

5. Centralise steering box.
For additional information, refer to: Steering Gear Centralization (211-00 Steering System - General Information, General Procedures).

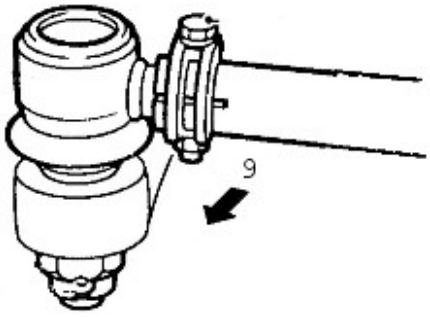
6. Align steering wheel, if necessary.

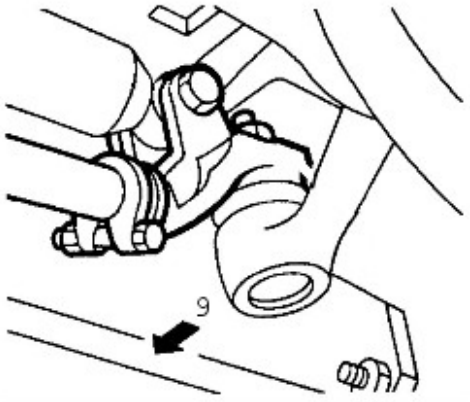
7. CAUTION: A sector shaft arm drag link that is damaged or bent must be renewed. DO NOT attempt repair.

Fit sector shaft arm drag link to swivel housing arms and tighten nuts to 40 Nm (30 lbf/ft). Fit new split pins.

8. Ensure full steering travel is obtained between lock stops.
For additional information, refer to: Steering Lock Stop Adjustment (211-00 Steering System - General Information, General Procedures).
Adjust sector shaft arm drag link length to suit.

9. Tap ball joints in direction shown so both pins are in same angular plane.





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10. Tighten clamp bolts to 14 Nm (10 lbf/ft).

11. Refit road wheel and remove axle stands or vehicle from ramp.

12. Road test vehicle.

13. WARNING: To correct steering wheel deviations greater than ± 5° remove and reposition steering wheel.

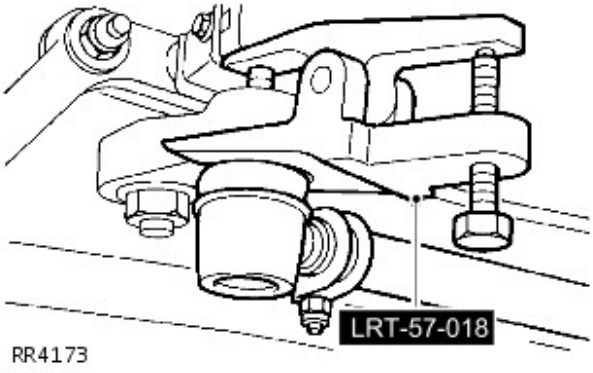
If driving straight ahead and steering wheel is offset by 0° ± 5° in either direction, correct by adjusting sector shaft arm drag link length.

Steering Linkage - Steering Gear Drop Arm

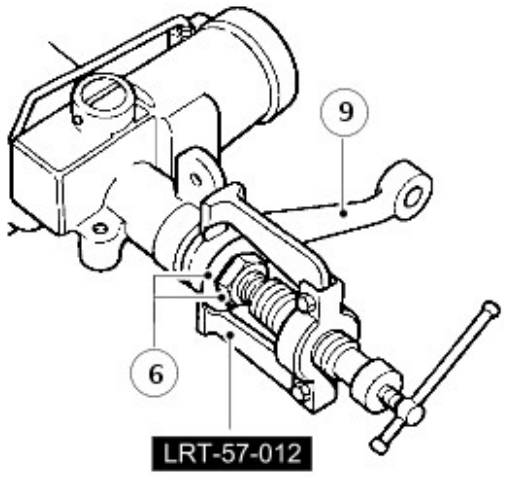
Removal and Installation

Removal

1. Park vehicle on level surface and chock rear wheels.
2. Raise vehicle and locate axle stands or use a ramp.
3. Disconnect steering linkage damper from drag link.
   For additional information, refer to: Steering Linkage Damper (211-03 Steering Linkage, Removal and Installation).
4. Disconnect drag link ball joint from drop arm using extractor LRT-57-018.



5. Mark drop arm and steering box for reassembly.
6. Bend back tabs on locking washer, slacken retaining nut, but do not remove.
7. Fit extractor LRT-57-012 and release drop arm from steering box spline.
8. Remove nut and discard locking washer.
9. Remove drop arm.



Installation

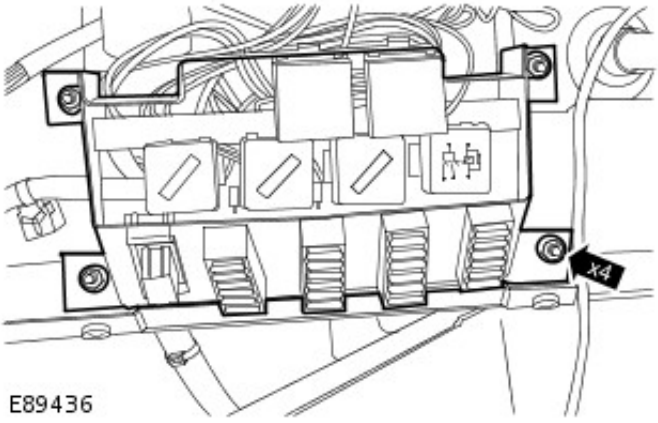
1. Centralise steering box.
   For additional information, refer to: Steering Gear Centralization (211-00 Steering System - General Information, General Procedures).
2. Align reassembly marks and fit drop arm onto steering box splines.
3. Install new tab washer and retaining nut. Tighten to 176 Nm (130 lbf.ft) and bend over tab washer.
4. Install drag link to drop arm. Tighten ball joint nut to 40 Nm (30 lbf.ft).
5. Remove axle stands or vehicle from ramp.

Steering Column - Steering Column
Removal and Installation

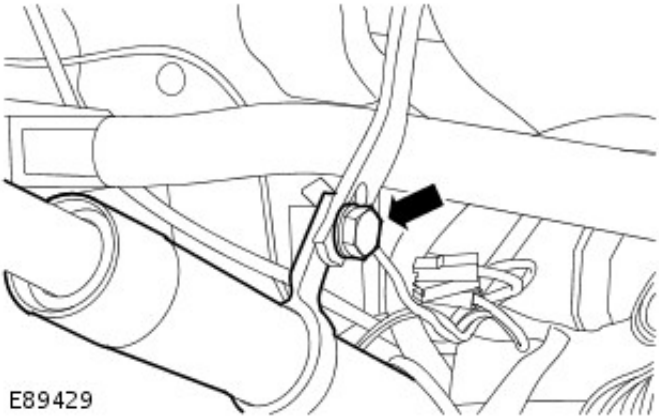
Removal

- NOTE: Make sure that the wheels and tires are in the straight-ahead position.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the instrument panel.
   For additional information, refer to: Instrument Panel (501-12 Instrument Panel and Console, Removal and Installation).
3. Remove the steering column lock and ignition switch housing.
   For additional information, refer to: Steering Column Lock and Ignition Switch Housing (211-05 Steering Column Switches, Removal and Installation).
4. Release the central junction box (CJB) from the bulkhead.
   - Remove the 4 nuts.



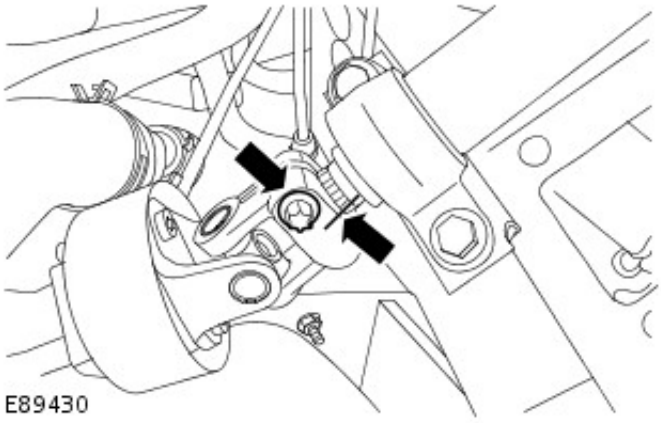
5. Release the steering column.
   - Remove the bolt.



6. Remove the brake pedal and bracket.
   For additional information, refer to: Brake Pedal and Bracket (206-06 Hydraulic Brake Actuation, Removal and Installation).
7. Release the steering column from the lower shaft.

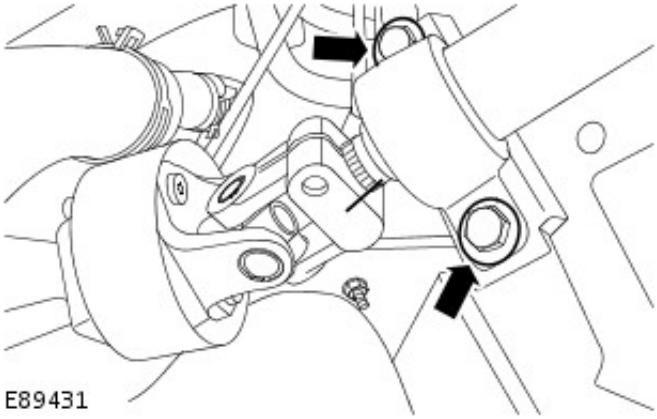
7. Release the steering column from the lower shaft.

- Mark the relationship between both shafts.
- Remove and discard the bolt.



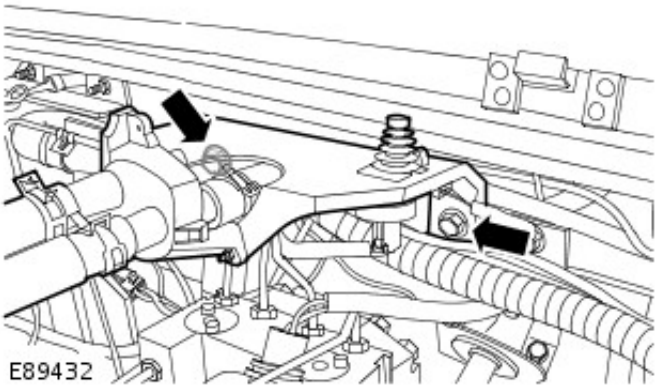
8. Release the steering column from the vehicle body.

- Remove the 2 bolts.



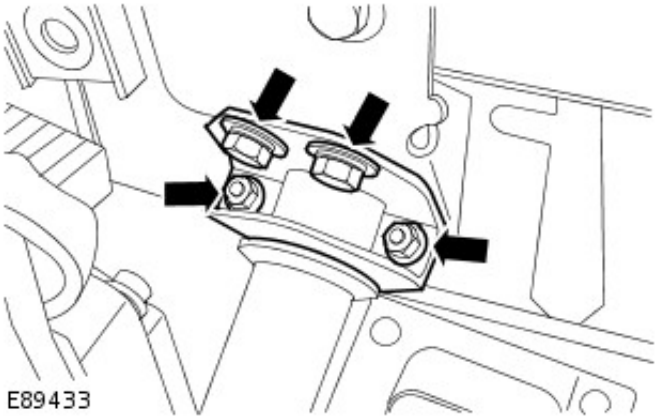
9. Release the heater control valve and bracket.

- Remove the 2 bolts.

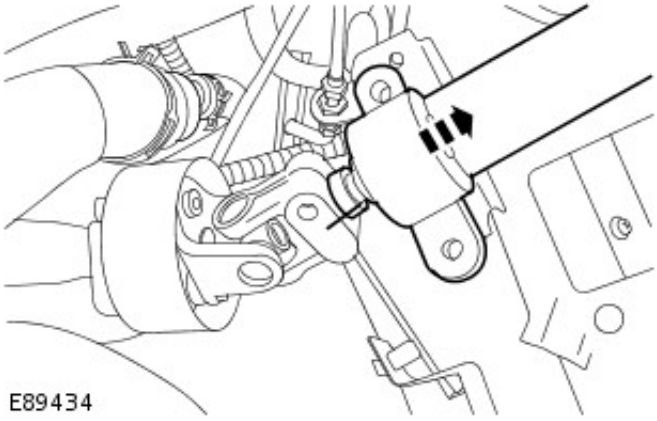


10. Remove the steering column upper support bracket.

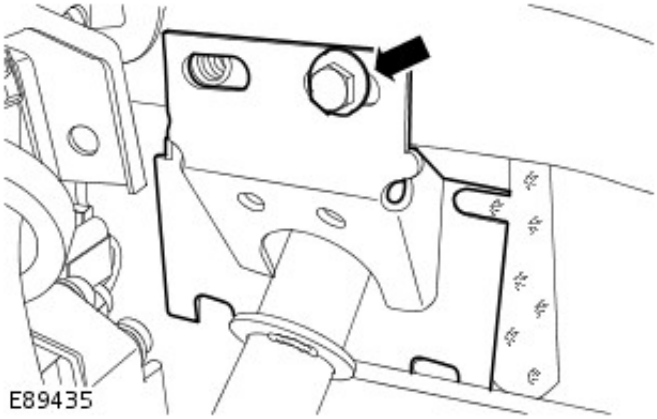
- Remove the 4 bolts.
- Collect the rubber strip from around the steering column shaft.



11. Remove the steering column from the steering column

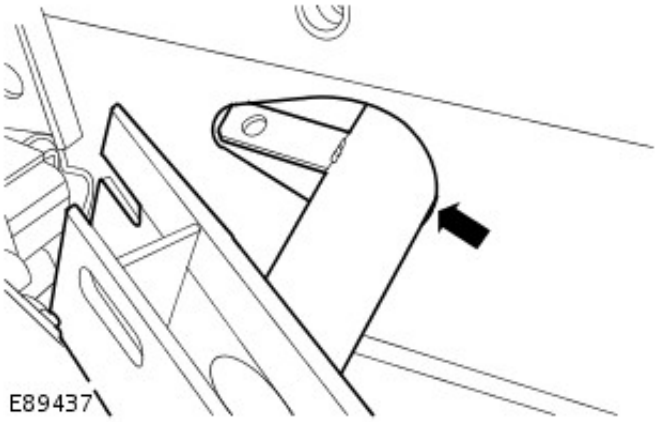


lower shaft.



12. Release the steering column main support bracket.

- Remove the bolt.

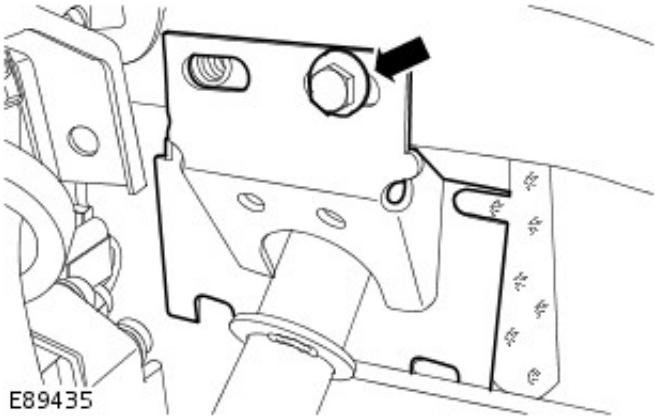


13. NOTE: The steering column must be positioned correctly to pass through the bulkhead.

Remove the steering column.

Installation

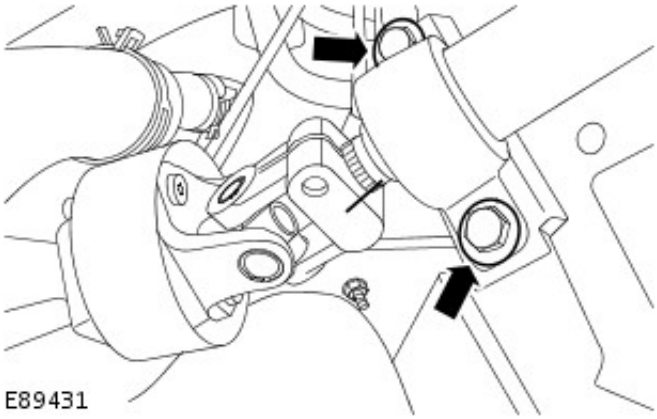
CAUTION: Care must be taken when installing the steering column to the steering column lower shaft, failure to follow this instruction may result in damage to the steering column lower shaft.



1. To install, reverse the removal procedure.

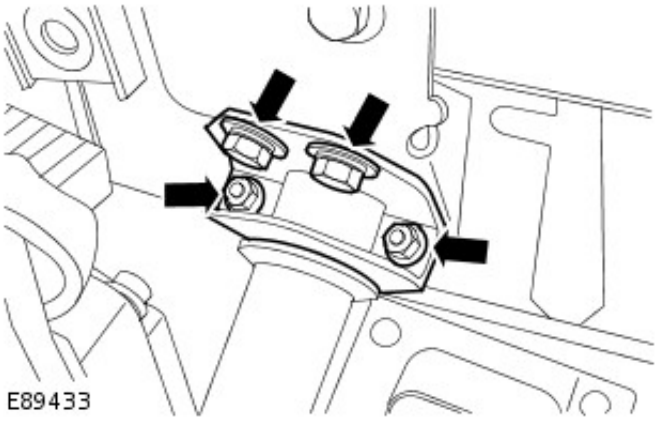
- Tighten to 22 Nm (16 lb.ft).

2. Tighten to 22 Nm (16 lb.ft).

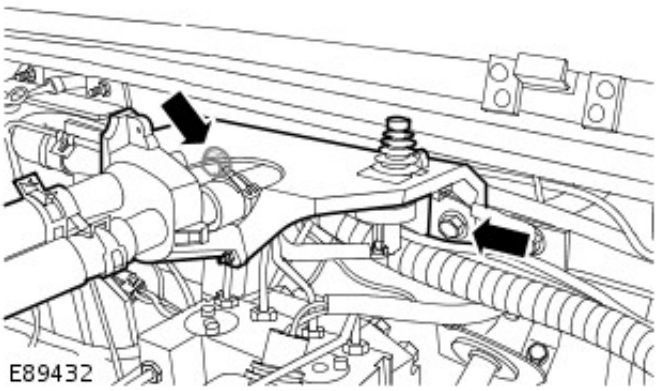


3. Install the steering column upper support bracket.

- Tighten the M6 bolts to 9 Nm (7 lb.ft).
- Tighten the M8 bolts to 22 Nm (16 lb.ft).

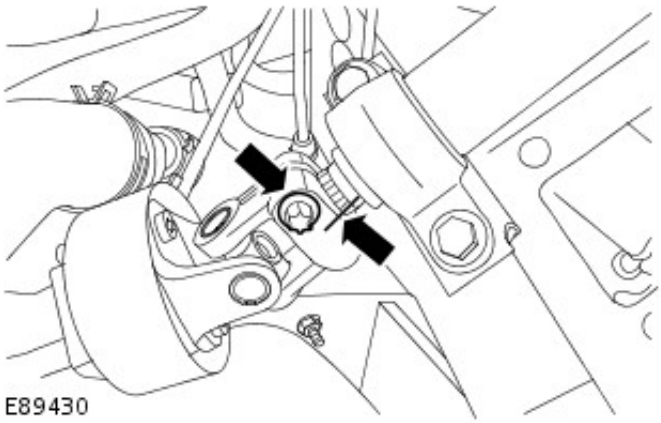


4. Tighten to 22 Nm (16 lb.ft).

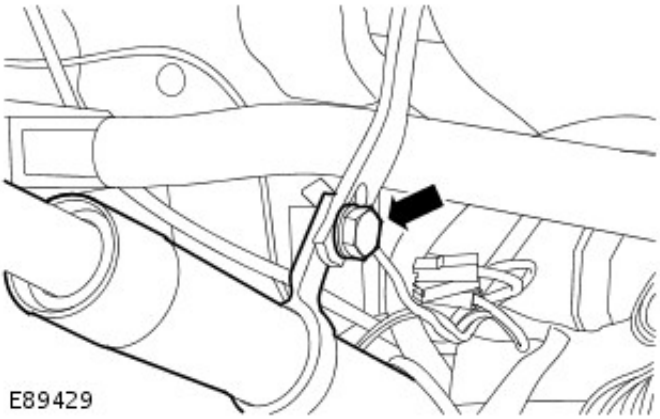


5. NOTE: Install a new bolt.

Tighten to 30 Nm (22 lb.ft).



6. Tighten to 48 Nm (35 lb.ft).

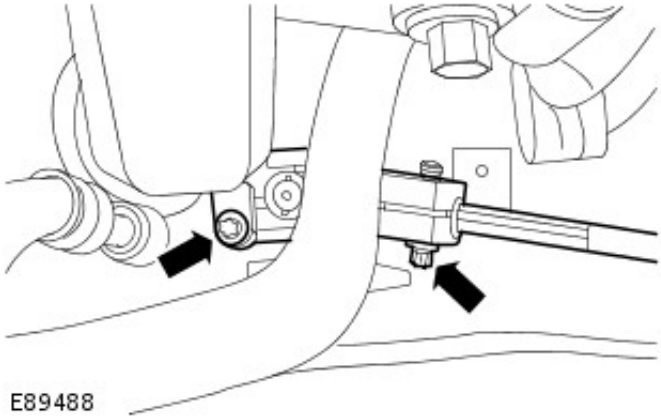


7. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Steering Column - Steering Column Lower Shaft
Removal and Installation

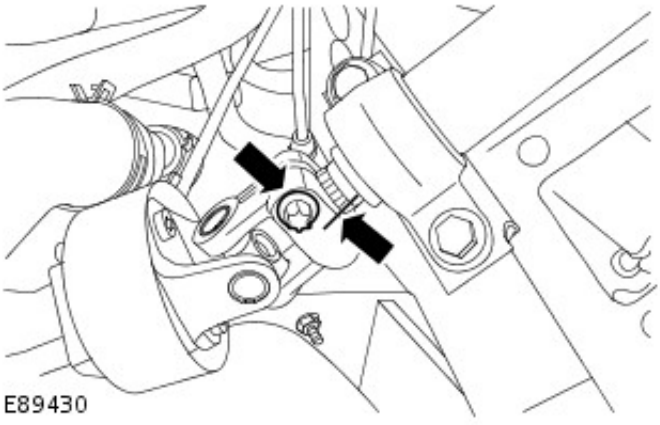
Removal

• NOTE: Make sure that the wheels and tires are in the straight-ahead position.



1. Release the steering column lower shaft.

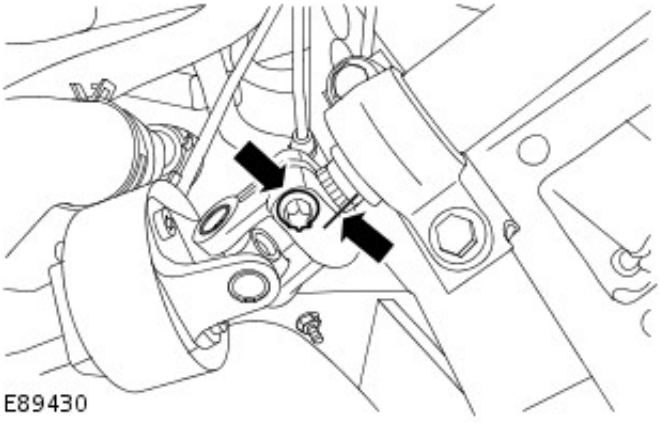
- Remove and discard the 2 bolts.



2. Remove the steering column lower shaft.

- Mark the relationship between both shafts.
- Remove and discard the bolt.

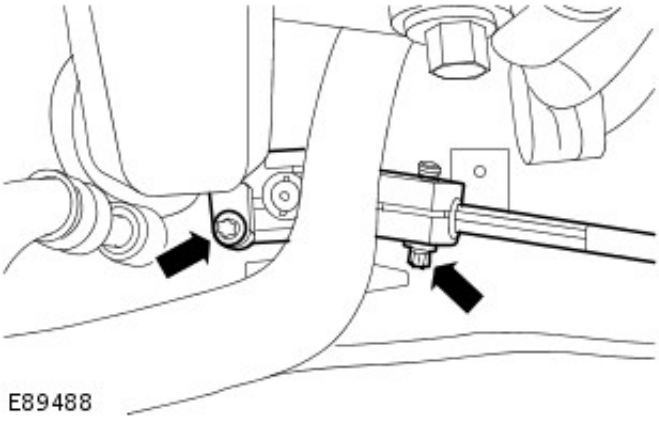
Installation



1. To install, reverse the removal procedure.

- Tighten to 30 Nm (22 lb.ft).

2. Tighten to 30 Nm (22 lb.ft).

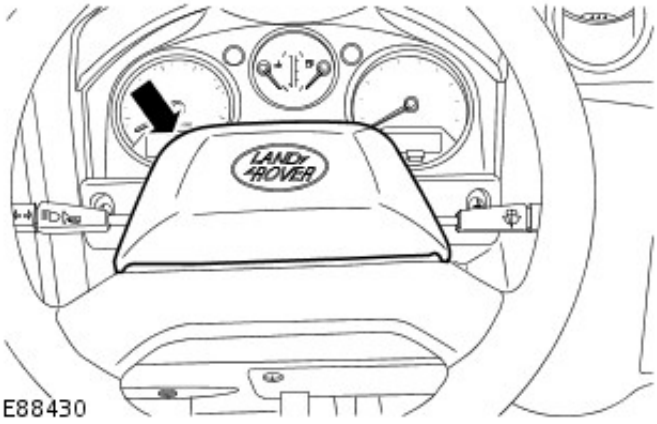

E89488

Steering Column - Steering Wheel
Removal and Installation

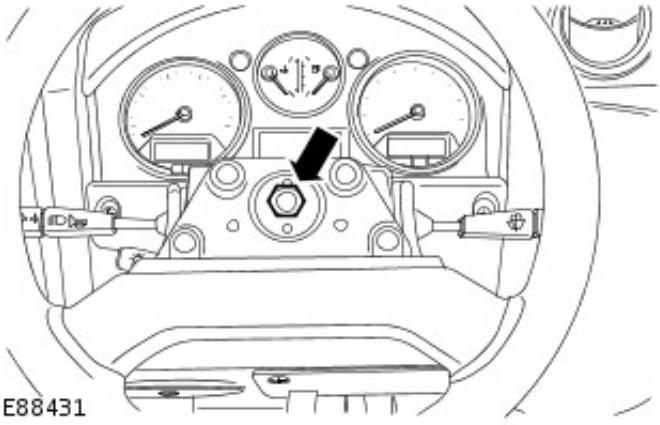
Special Tool(s)	
	Remover, Steering Wheel 211-295

Removal

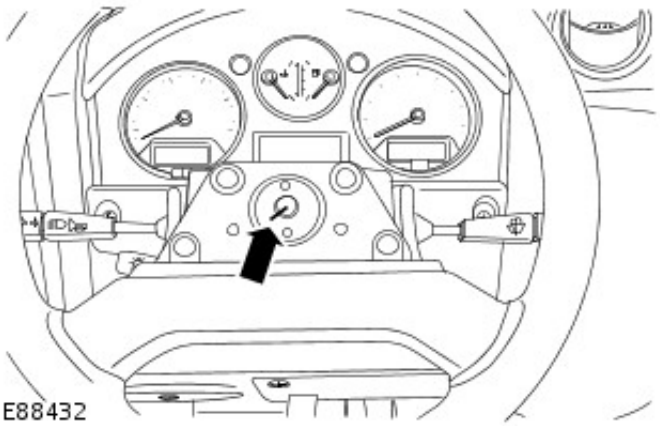
- NOTE: Make sure that the wheels and tires are in the straight-ahead position.



1. Remove the steering wheel center pad.

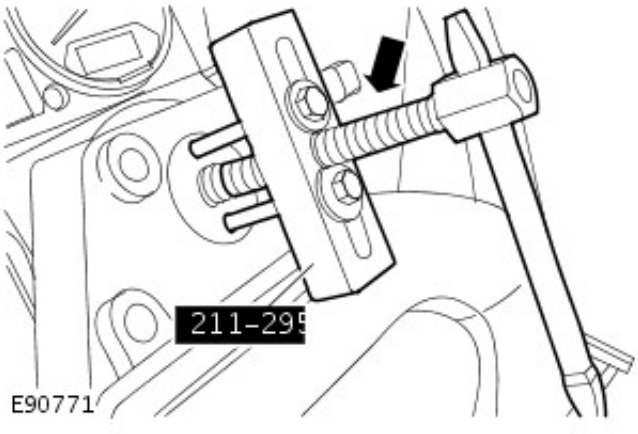


2. Remove the steering wheel nut and locking washer.

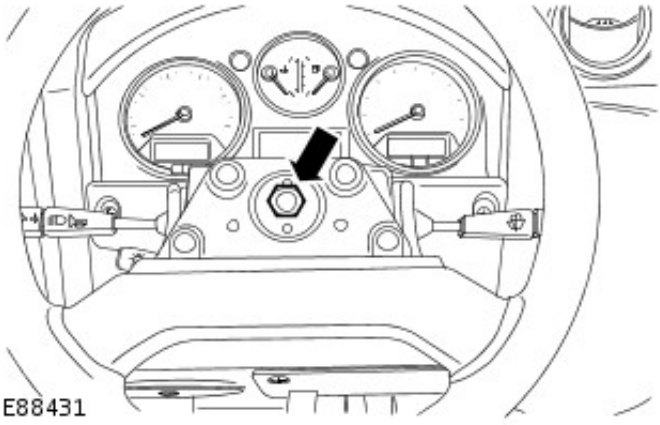


3. Mark the relationship between the steering wheel and steering column.

4. Using the special tool, remove the steering wheel.



Installation



1. NOTE: Make sure the alignment marks are correctly aligned.

Install the steering wheel.

- Tighten to 43Nm (32 lb.ft).

2. Install the steering wheel center pad.

Steering Column Switches - Steering Column Switches

Description and Operation

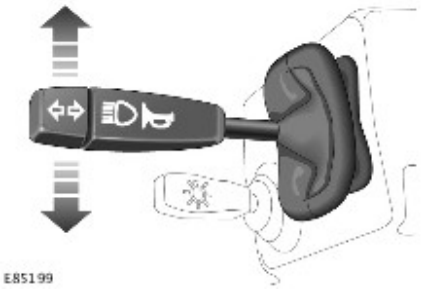
OVERVIEW

The steering column switches comprise the steering column multifunction switch and the ignition switch. Both switches are located on the steering column assembly.

The steering column multifunction switch comprises a case, which houses a turn signal indicator switch assembly and a windshield wiper switch assembly. The multifunction switch is located behind the steering wheel and is secured at the top of the steering column assembly and at the bottom of the column lock housing.

LEFT HAND COLUMN SWITCH

Turn Signal Indicator Switch

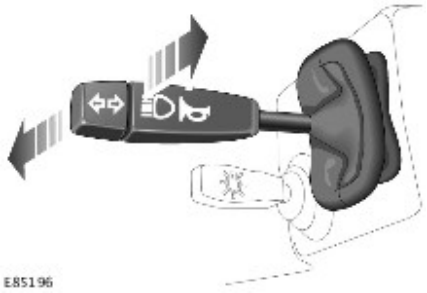


The turn signal indicator switch assembly is located in the Left Hand (LH) side of the case. The switch is connected to the main harness via a connector on the back of the switch. The switch controls the following functions:

- Left/right turn signal operation
- High/low beam operation
- Headlamp flash
- Horn operation

The turn signal indicators are operated by pushing the switch up for Right Hand (RH) indicators and down for LH indicators. The switch has a detent position, which locks the switch in the selected position until it is moved to the central off position. The LH and RH turn signal indicator switch positions are connected on separate wires to the hazard warning relay, via the hazard warning switch. When a switch position selection is made, a circuit is completed from the hazard warning relay to ground, via the selected switch position. The hazard warning relay detects the completed circuit and operates the selected turn signal indicator until the switch is moved to the central off position. The turn signal indicators can be cancelled either manually by the driver or automatically when the steering wheel is rotated to the straight ahead position.

High/Low Beam and Headlamp Flash

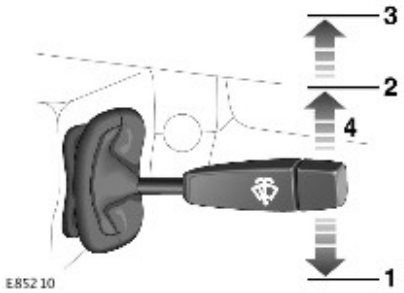


High beam is operated by pushing the switch forwards. The switch is latched in this position and the high beam is active until the switch is manually pulled rearwards. The headlamp flash function is operated by pulling the switch rearwards. The switch contacts complete a circuit and the headlamps are activated for as long as the switch is operated. The switch is non-latching in this position and the headlamp flash is switched off when the switch is released and it returns to its off position. The high beam and headlamp flash positions are connected on separate wires to the high/low beam relay and ground. When a switch selection is made, a circuit is completed from the high/low beam relay to ground via the switch contacts.

RIGHT HAND COLUMN SWITCH

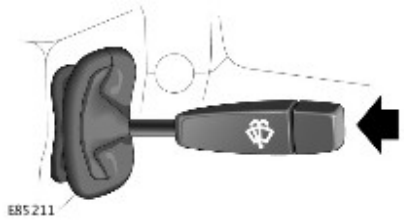
Windshield Wiper and Washer Switch Assembly

Wiper



Item	Part Number	Description
1	-	Intermittent wipe
2	-	Low speed wipe
3	-	High speed wipe
4	-	Single wipe

Washer



The windshield wiper functions are operated by moving the switch up or down. Flick wipe is selected by pushing the switch up against the spring pressure. The flick wipe switch contact is connected on a single wire to the windshield wiper delay Electronic Control Unit (ECU) and ground. When the switch is operated the circuit is completed between the delay ECU and ground. With the circuit completed the wipers operate for as long as the switch contact is made.

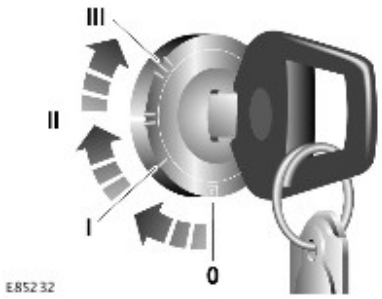
Intermittent is selected by pushing the wiper switch down, to the detent position, the wipers operate at a delay period, which is controlled by the windshield wiper delay ECU. The wipers remain in the intermittent mode until the wiper switch is moved to the off or slow/fast speed positions. The intermittent switch contact is connected between the delay ECU and ground. When the switch is moved to the intermittent position the circuit is completed. With the circuit completed, the wipers operate in intermittent for as long as the switch contact is made.

Slow speed operation is selected by pushing the wiper switch up, to the second detent position. The wipers operate at slow speed until the wiper switch is moved to the off, intermittent or fast speed positions. The slow speed switch contact is connected between the delay ECU and ground. When the switch is moved to the slow speed position the circuit is completed. With the circuit completed, the wipers operate at slow speed for as long as the switch contact is made.

Fast speed operation is selected by pushing the wiper switch up, to the second detent position. The wipers operate at fast speed until the wiper switch is moved to the off, intermittent or slow speed positions. The fast speed switch contact is connected between the delay ECU and ground. When the switch is moved to the fast speed position the circuit is completed. With the circuit completed, the wipers operate at fast speed for as long as the switch contact is made.

The windshield washers are operated by pressing the button on the end of the wash/wipe stalk located on the RH side of the steering column. When the button is pressed, the washers operate immediately and stop immediately the button is released. The washer button contact is connected between the delay ECU and ground. When the button is pressed the circuit is completed. With the circuit completed, the washers operate for as long as the contact is made.

IGNITION SWITCH



The ignition switch is located in the LH end of the steering column assembly. The switch is held in the column lock casting with 2 locking tabs, which engage in slots in the column lock casting.

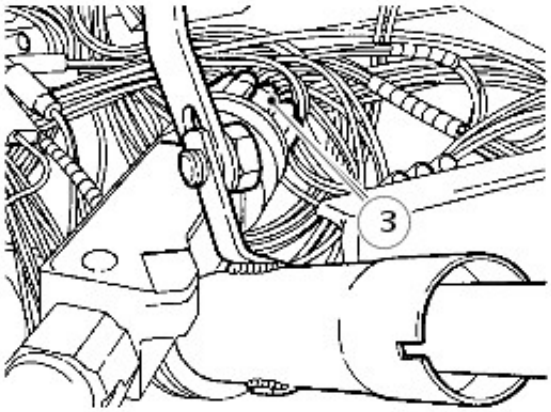
The switch has a slot, which provides for the location of the drive shaft. The drive shaft passes through the column lock. This shaft is rotated by the driver when the ignition key is turned in the key barrel. This rotation turns a drum inside the ignition switch, which moves 2 electrical contacts to select the required ignition position. A spring loaded ball locates in a seat for each of the 3 ignition switch positions, allowing the driver to feel when the required position is reached.

Steering Column Switches - Ignition Switch

Removal and Installation

Removal

1. Remove instrument cluster.
   For additional information, refer to: Instrument Cluster (413-01, Removal and Installation) / Instrument Cluster (413-01 Instrument Cluster, Removal and Installation).
2. Remove steering column shroud.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation) / Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Note position of harness leads on back of ignition switch and disconnect harness leads. If fitted, remove anti theft system passive coil from switch.



J6438

4. Remove single screw and withdraw ignition switch from steering column lock.

Installation

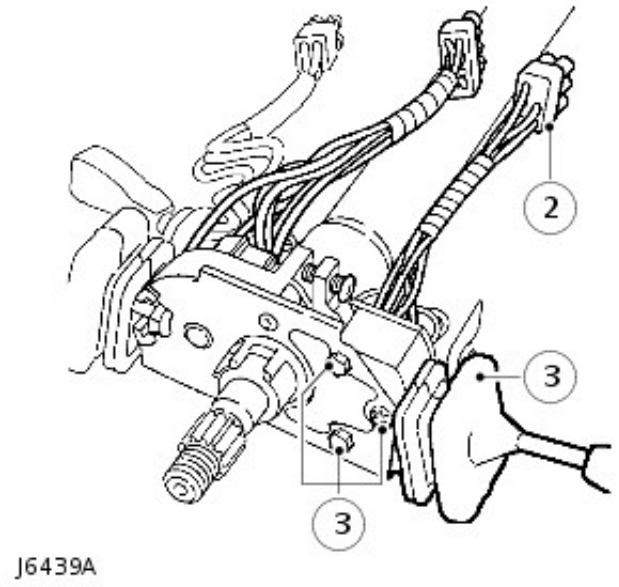
1. Fit new switch in steering column lock.
2. Connect harness leads to ignition switch.
3. If applicable, fit anti theft system passive coil.
4. Fit steering column shroud.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation) / Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
5. Fit instrument cluster.
   For additional information, refer to: Instrument Cluster (413-01, Removal and Installation) / Instrument Cluster (413-01 Instrument Cluster, Removal and Installation).

Steering Column Switches - Steering Column Multifunction Switch RH

Removal and Installation

Removal

1. Remove steering column shroud.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect switch multiplug from main harness.
3. Remove 2 screws and shake proof washer securing switch to mounting bracket.



J6439A

4. Remove switch complete with harness.

Installation

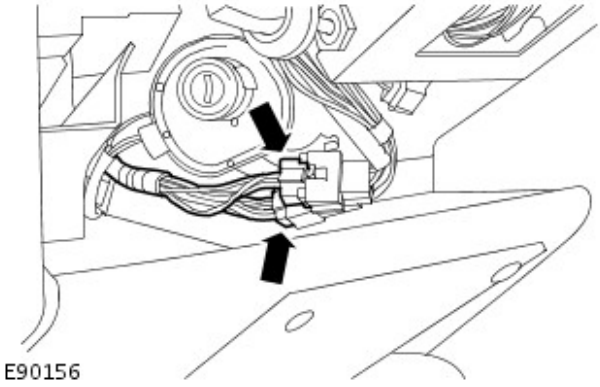
1. Fit new switch to mounting bracket.
2. Reconnect switch multiplug.
3. Fit steering column shroud.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).

Steering Column Switches - Steering Column Multifunction Switch LH

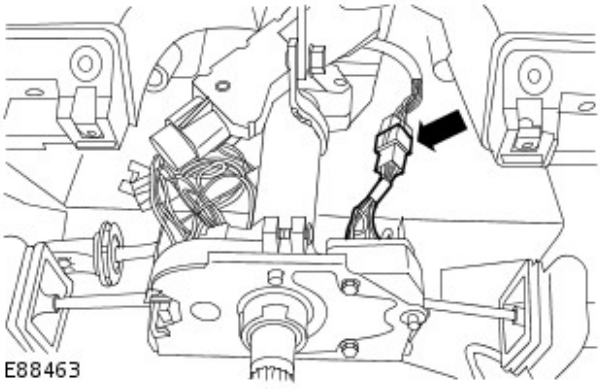
Removal and Installation

Removal

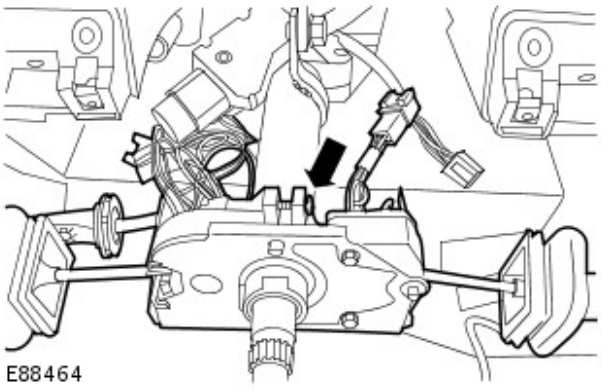
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the steering wheel.
   For additional information, refer to: Steering Wheel (211-04 Steering Column, Removal and Installation).
3. Remove the steering column shrouds.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
4. Disconnect the 2 electrical connectors.



5. Disconnect the electrical connector.



6. Remove the steering column multifunction switch assembly.
   - Undo but do not remove the multifunction switch clamp screw.



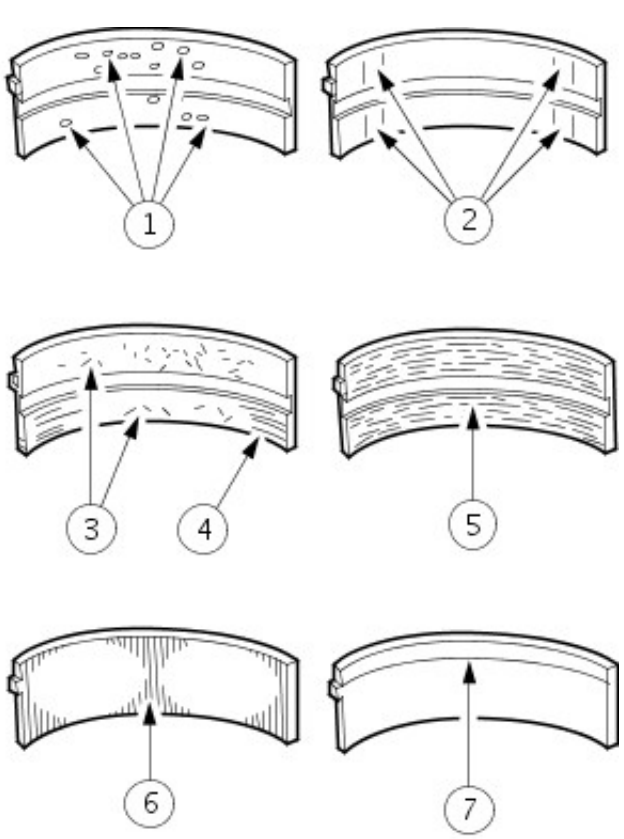
Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

3: Powertrain

Engine System - General Information - Bearing Inspection

General Procedures



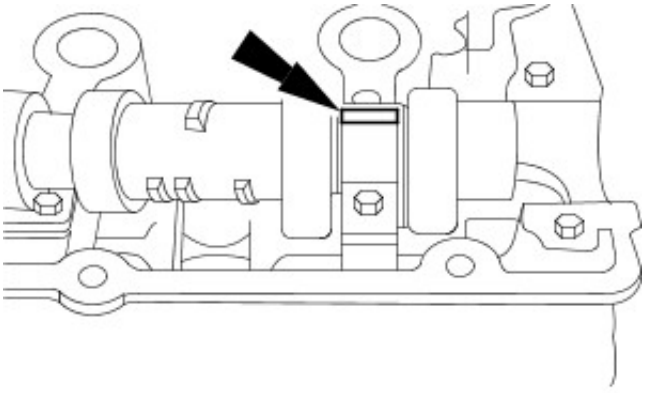
VUJ0002219

1. Inspect bearings for the following defects.

1. Cratering - fatigue failure
2. Spot polishing - incorrect seating.
3. Imbedded dirt engine oil.
4. Scratching - dirty engine oil.
5. Base exposed - poor lubrication.
6. Both edges worn - journal damaged.
7. One edge worn - journal tapered or bearing not seated.

Engine System - General Information - Camshaft Bearing Journal Clearance

General Procedures



VUJ0001696

1. NOTE: Make sure that the following stages are followed exactly. The tappets or followers must be removed to carry out this measurement.

• NOTE: Make sure that the camshaft is to specification.

• NOTE: The bearing caps and journals should be free from engine oil and dirt.

Position on a length of plastigage on the bearing cap.

- Insert the camshaft, without lubrication, into the cylinder head.
- Position a plastigage strip, which should be equal to the width of the bearing cap, on the bearing journal.

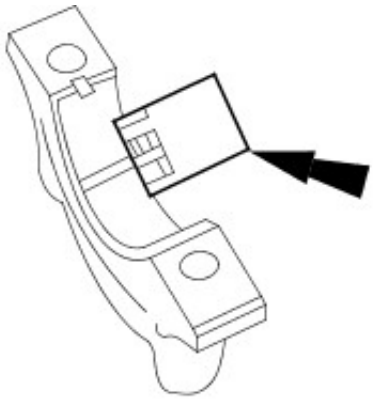
2. Install the camshaft bearing caps.

- Follow the relevant tightening sequence.

3. NOTE: Do not strike the bearing caps.

Remove the camshaft bearing caps.

- Follow the relevant loosening sequence.



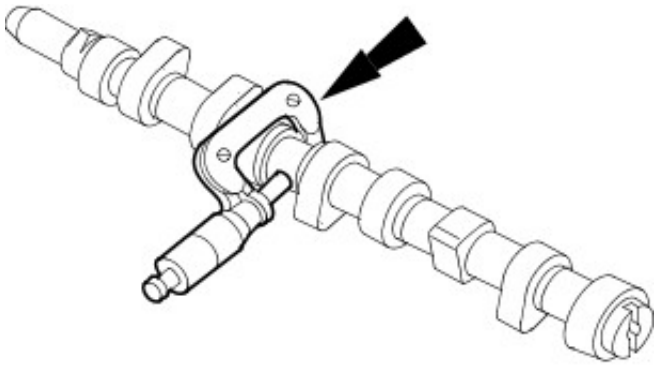
VUJ0001697

4. Using the special tool, read off the measurement.

- Compare the width of plastigage with the plastigage scale.
- The value that is read off is the bearing clearance.
- If the values are not to specification install a new camshaft.

Engine System - General Information - Camshaft Bearing Journal Diameter

General Procedures



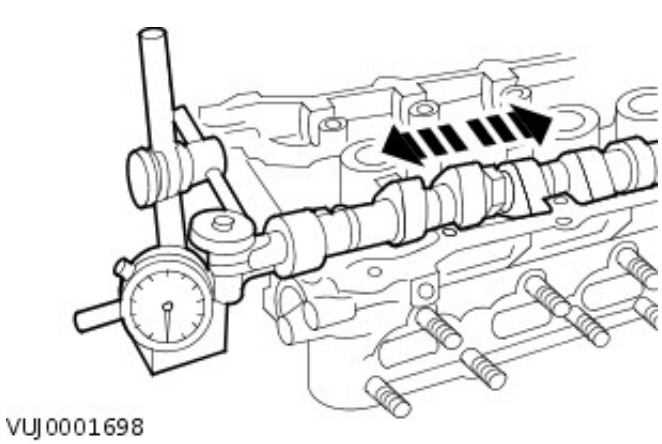
VUJ0001695

1. Determine the diameter of the camshaft journals.

- Using a micrometer measure the diameter at 90 degrees intervals to determine if the journals are out-of-round.
- Measure at two different points on the journal to determine if there is any tapering.
- If the measurements are out of the specified range, install a new camshaft.

Engine System - General Information - Camshaft End Play

General Procedures



VUJ0001698

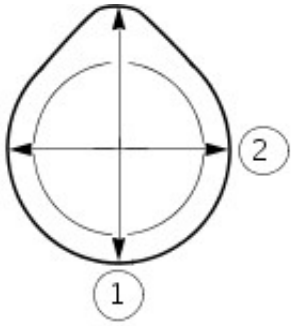
1. NOTE: Make sure that the camshaft is to specification.

Using the special tool, measure the end play.

- Slide the camshaft in both directions. Read and note the maximum and minimum values on the dial indicator gauge.
  1. End play = maximum value minus minimum value.
- If the measurement is out of specification, install new components.

Engine System - General Information - Camshaft Lobe Lift

General Procedures

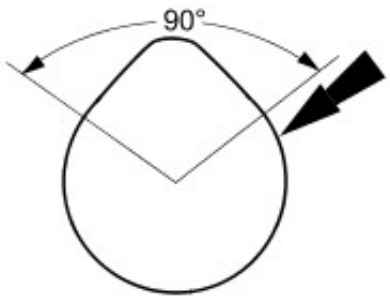


VUJ0001699

1. Measure the diameter (1) and diameter (2) with a vernier caliper. The difference in measurements is the lobe lift.

Engine System - General Information - Camshaft Surface Inspection

General Procedures

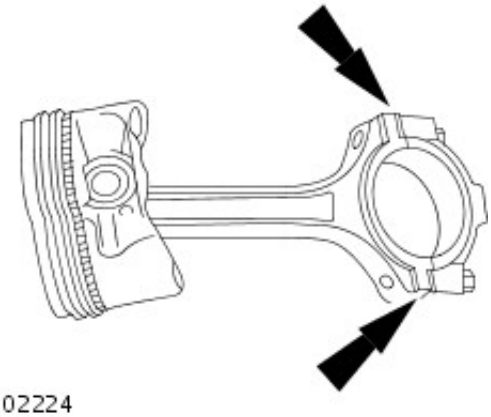


VUJ0001700

1. Inspect camshaft lobes for pitting or damage in the active area. Minor pitting is acceptable outside the active area.

Engine System - General Information - Connecting Rod Cleaning

General Procedures



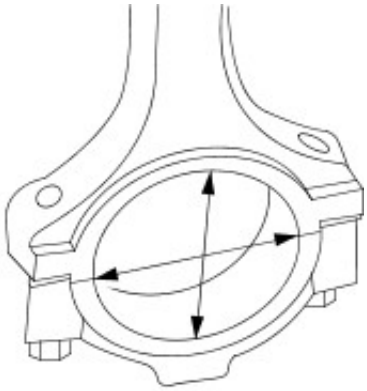
VUJ0002224

1. CAUTION: Do not use a caustic cleaning solution or damage to connecting rods may occur.

Mark and separate the parts and clean with solvent. Clean the oil passages.

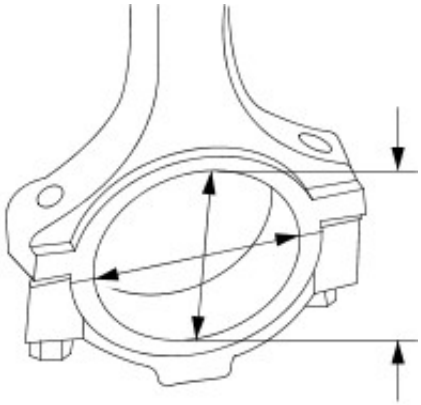
Engine System - General Information - Connecting Rod Large End Bore

General Procedures



VUJ0002223

1. Measure the bearing bore in two directions. The difference is the connecting rod bore out-of-round. Verify the out-of-round is within specification.

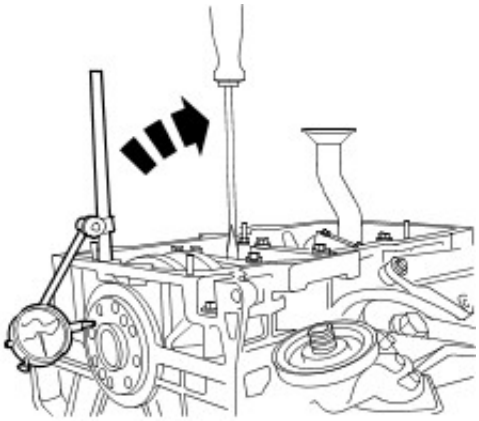


VUJ0002222

2. Measure the bearing bore diameter in two directions. Verify the bearing bore is within specification.

Engine System - General Information - Crankshaft End Play

General Procedures



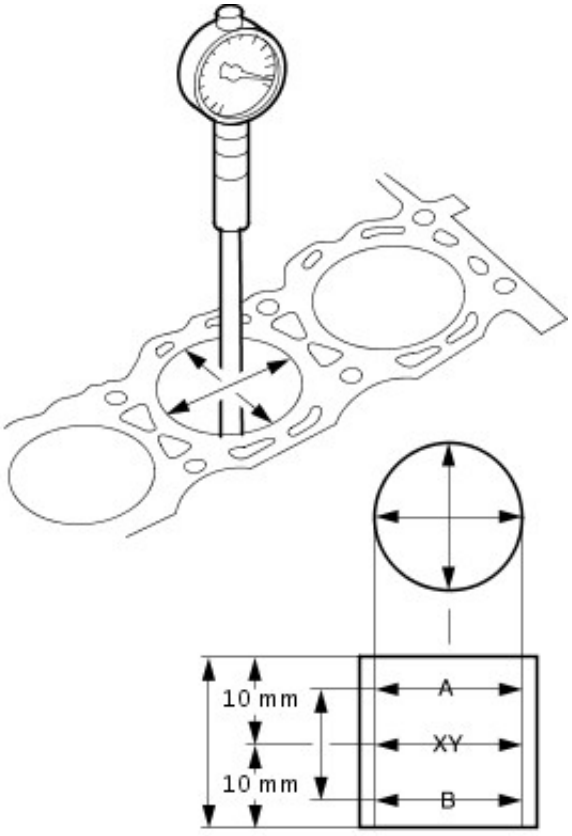
VUJ0002235

1. Using the Dial Indicator Gauge with Brackets, measure the end play.

- Measure the end play by lifting the crankshaft using a lever.
- If the value is out of the specification, install new thrust half rings to take up the end float and repeat the measurement.

Engine System - General Information - Cylinder Bore Out-of-Round

General Procedures



VUJ0002234

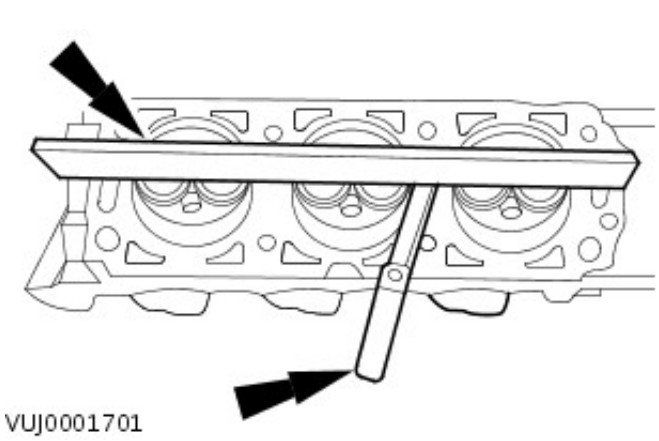
1. NOTE: The main bearing caps or lower crankcase must be in place and tightened to the specified torque; however, the bearing shells should not be installed.

Measure the cylinder bore with an internal micrometer.

- Carry out the measurements in different directions and at different heights to determine if there is any out-of-roundness or tapering.
- If the measurement is out of the specified range, hone out the cylinder block or install a new block.

Engine System - General Information - Cylinder Head Distortion

General Procedures



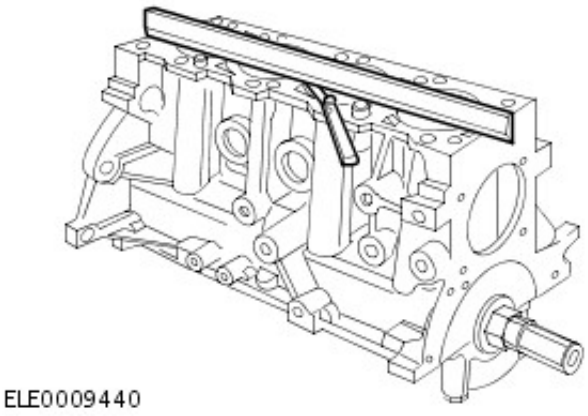
VUJ0001701

1. Measure the cylinder block/cylinder head distortion.

- Using the special tool, measure the mating face distortion.
- If the value is not to specification rework the mating face.

Engine System - General Information - Cylinder Block Distortion

General Procedures



ELE0009440

1. Using a Straight Edge and a Feeler Gauge, measure the cylinder block/cylinder head distortion.

- Measure the mating face distortion.
- If the value is not to specification rework the mating face (if allowed).

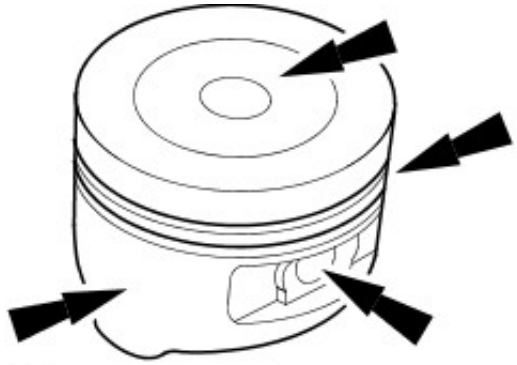
Engine System - General Information - Exhaust Manifold Cleaning and Inspection

General Procedures

1. Inspect the cylinder head joining flanges of the exhaust manifold for evidence of exhaust gas leaks.
2. Inspect the exhaust manifold for cracks, damaged gasket surfaces, or other damage that would make it unfit for further use.

Engine System - General Information - Piston Inspection

General Procedures



VUJ0002233

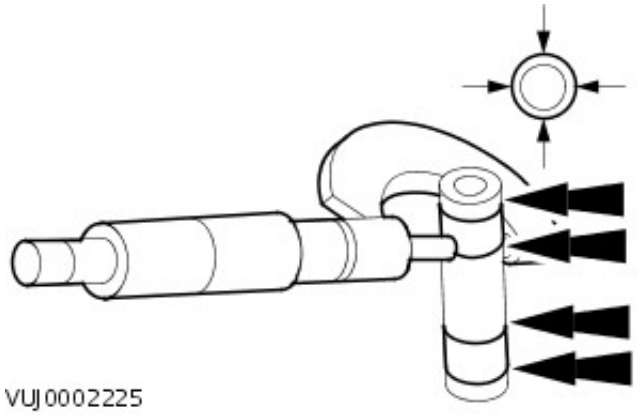
1. CAUTION: Do not use any aggressive cleaning fluid or a wire brush to clean the piston.

Carry out a visual inspection.

- Clean the piston skirt, pin bush, ring grooves and crown and check for wear or cracks.
- If there are signs of wear on the piston skirt, check whether the connecting rod is twisted or bent.

Engine System - General Information - Piston Pin Diameter

General Procedures



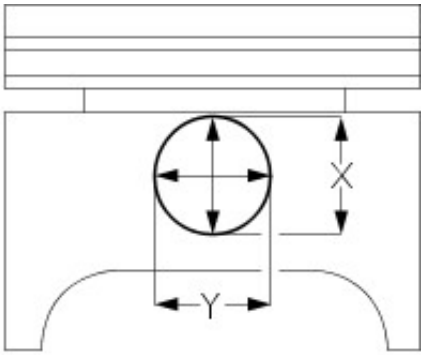
1. NOTE: The piston and piston pin are a matched pair. Do not mix up the components.

Measure the piston pin diameter.

- Measure the diameter in two directions.
- If the values are not to specification, install a new piston and a new piston pin.

Engine System - General Information - Piston Pin to Bore Diameter

General Procedures



VUJ0002232

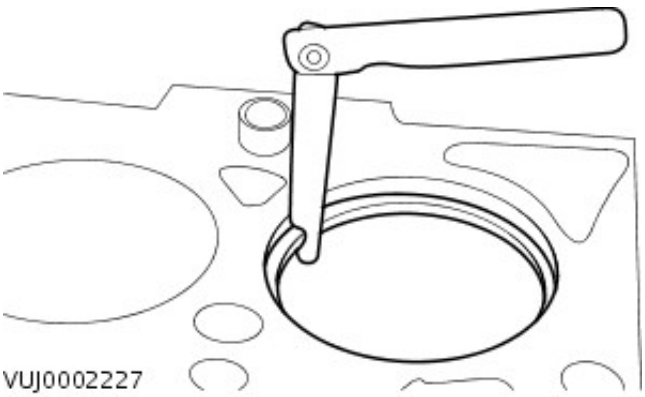
1. NOTE: The piston and piston pin form a matched pair. Do not mix up the components.

Measure the diameter of the piston pin bore.

- Measure the diameter in two directions.
- If the values are not to specification, install both a new piston and a new piston pin.

Engine System - General Information - Piston Ring End Gap

General Procedures



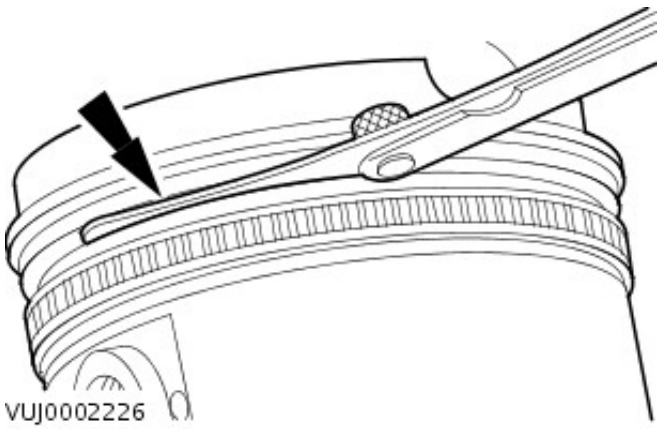
1. CAUTION: Do not mix up the piston rings. Install the piston rings in the same position and location.

Using the Feeler Gauge, measure the piston ring gap.

- The values given in the specification refer to a gauge ring used during production.

Engine System - General Information - Piston Ring-to-Groove Clearance

General Procedures

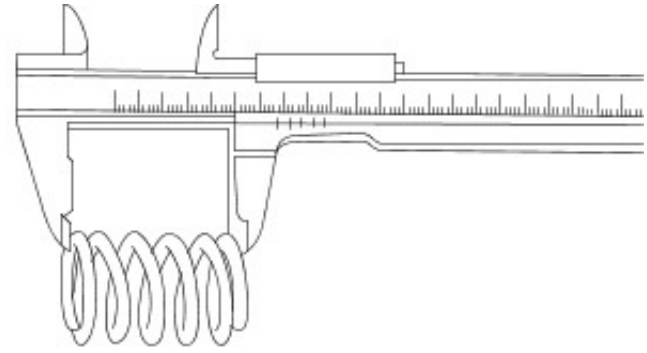


1. NOTE: The piston ring must protrude from the piston groove. To determine the piston ring clearance, insert the Feeler Gauge right to the back of the groove, behind the wear ridge.

Using the Feeler Gauge, measure the piston ring clearance.

Engine System - General Information - Valve Spring Free Length

General Procedures

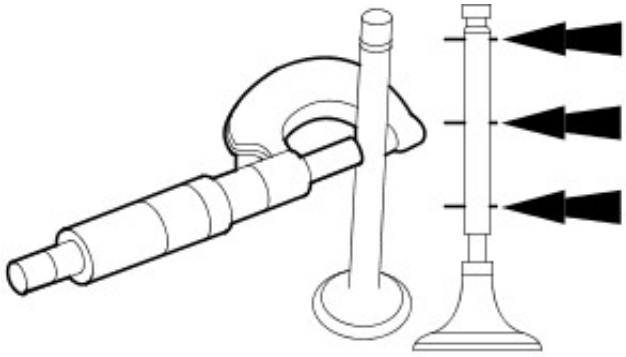


VUJ0002221

1. Using a vernier gauge, measure the free length of each valve spring. Verify the length is within specification.

Engine System - General Information - Valve Stem Diameter

General Procedures



VUJ0002220

1. Using a micrometer measure the diameter of the valve stems.

- If the measurements are not to specification, install a new valve.

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Lubricants, Fluids and Sealers

Item	Specification
SAE 5W-30 engine oil	WSS-M2C913-B
Sealant — oil pan, camshaft carrier and engine front cover	WSE-M4G323-A4

Cylinder Head Dimensions

Description	mm
Maximum distortion — measured longitudinally and diagonally	0.10
Peak to valley height of mating surface	0.02
Cylinder head gasket thickness	
Piston protrusion of 0.310 - 0.400 mm	1.1 (one tooth)
Piston protrusion of 0.401 - 0.450 mm	1.15 (two teeth)
Piston protrusion of 0.451 - 0.500 mm	1.2 (three teeth)

Oil pressure specifications

Description	bar
Minimum oil pressure at idle speed	1.25
Minimum oil pressure at 2000 rpm	2.0

Description	Nm	lb-ft
Transmission to engine bolts	40	30
Engine mount nuts	80	59
Engine mount bolts	80	59
Engine mount bracket bolts	63	46
Valve cover bolts	10	7
+ Rocker shaft bolts		
Stage 1	10	7
Stage 2	Further 30 degrees	
Timing chain guide bolts	15	11
Timing chain tensioner nut	15	11
Timing chain tensioner bolts	15	11
Oil pump chain tensioner bolts	22	16
Camshaft sprocket bolts	35	24
Fuel injection pump sprocket bolts	33	26
Generator bolts	48	35
Generator mounting bracket bolts	25	18
Exhaust gas recirculation (EGR) valve to EGR valve outlet tube bolts	10	7
EGR valve to EGR cooler bolts	23	17
Exhaust manifold to EGR cooler bolts	23	17
Intake manifold bolts	15	11
Intake manifold to EGR valve outlet tube bolts	10	7
Coolant pump bolts	23	17
Oil level indicator tube bolt	10	7
Oil pump pickup tube bolts	10	7
Oil filter housing assembly bolts	23	17
Oil pump bolts	10	7
Oil pan drain plug	23	17
Oil pressure switch	15	11
Oil pan bolts		
Stage 1	7	5
Stage 2	14	10
Coolant manifold bolts	10	7
EGR cooler to cylinder head bolts	23	17
+ Cylinder head bolts	A	-
Engine front cover bolts	14	10
Engine front cover nuts	10	7
Glow plugs	10	7
Power steering pump bolts	23	17
Power steering pump bracket bolts	23	17
Exhaust manifold bolts	40	30
+ Exhaust manifold nuts	40	30
+ Exhaust manifold studs	20	15
Turbocharger oil return tube bolts	10	7
Turbocharger oil return tube clamp bolt	22	16
Turbocharger oil supply line banjo bolt	35	26

Engine lifting eye bolts	22	16
Crankshaft position sensor (CKP) bolt	7	5
+ Crankshaft pulley bolts		
Stage 1	45	33
Stage 2	Further 120 degrees	
Crankshaft rear oil seal carrier bolts	10	7
+ Flywheel bolts		
Stage 1	25	18
Stage 2	40	30
Stage 3	Further 48 degrees	
Crankshaft main bearing cap bolts		
Stage 1	45	33
Stage 2	80	59
Stage 3	Further 105 degrees	
Connecting rod bearing cap bolts		
Stage 1	30	22
Stage 2	Further 100 degrees	
Ladder frame bolts	23	17
Camshaft carrier bolts	A	-
Fuel injector clamp bolts		
Stage 1	6	4
Stage 2	Further 180 degrees	

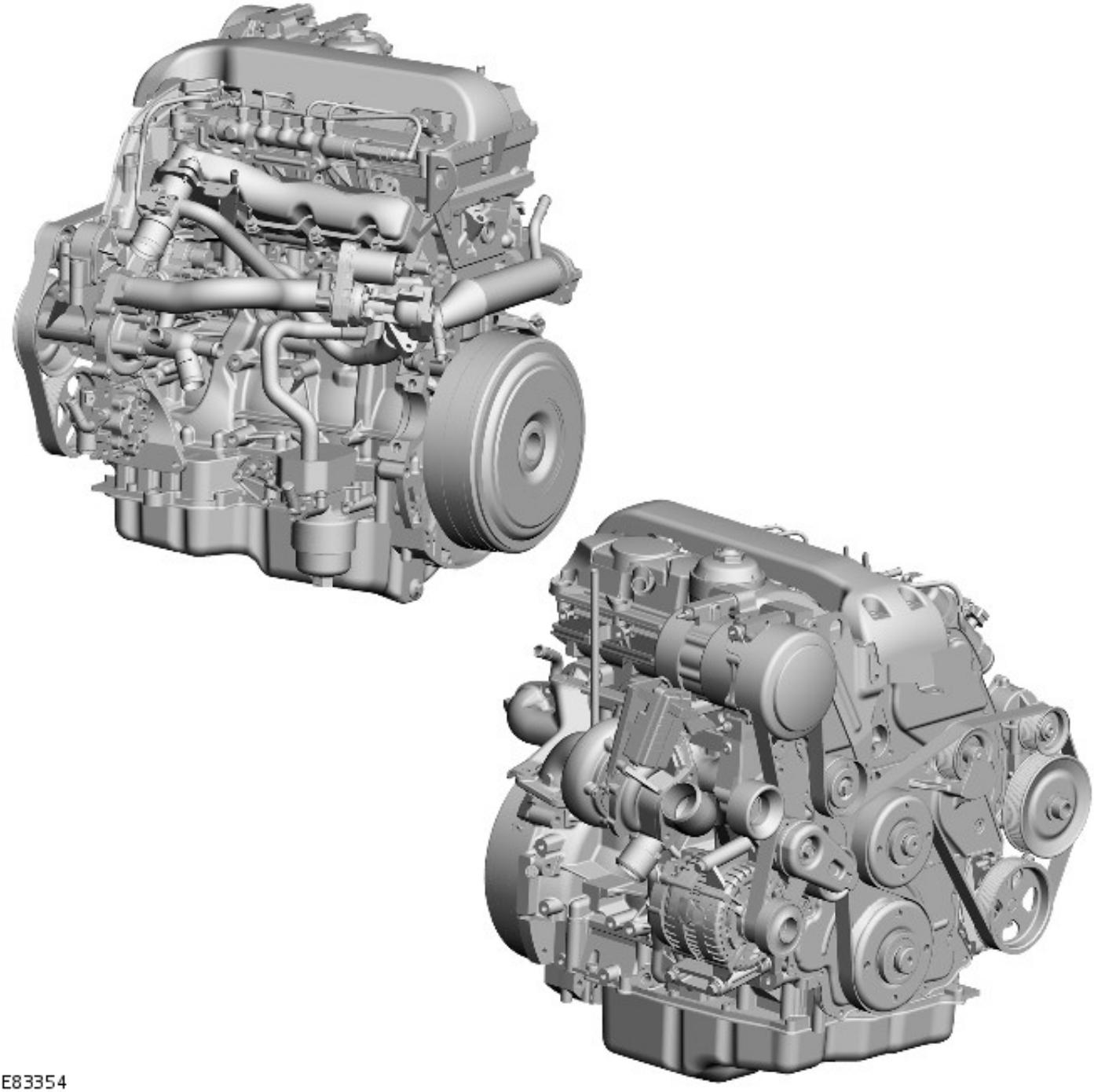
+ New nuts/bolts/studs must be installed

A - Refer to the procedure in this section

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine

Description and Operation

EXTERNAL VIEW



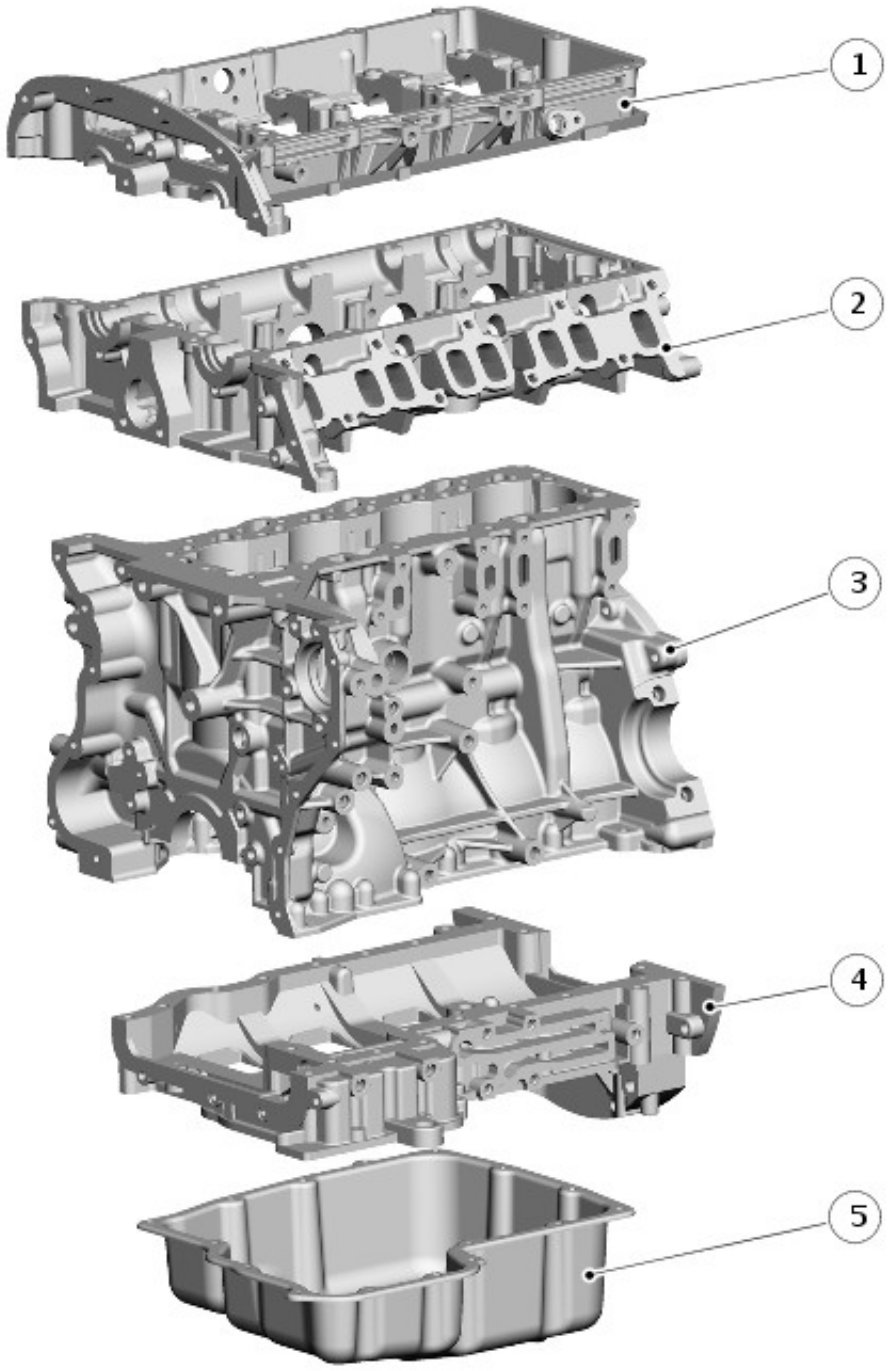
E83354

OVERVIEW

The 2.4 liter diesel engine is a 4 cylinder unit, direct injection, with 4 valves per cylinder, operated by 2 overhead camshafts. The engine emissions comply with European Commission Directive (ECD) 4 legislative requirements and employs a catalytic converter, electronic engine management control, positive crankcase ventilation and Exhaust Gas Re-circulation (EGR) to limit the emission of pollutants. The unit is water cooled and turbocharged. The fuel injection system features common rail technology.

The cylinder block is manufactured in Compacted Graphite Iron (CGI) and is coupled with a separate aluminum ladder frame to provide a lightweight, compact and very stiff bottom end of the engine. The cylinder head is cast aluminum with a moulded plastic camshaft cover. The single-piece oil sump is formed from pressed steel. The exhaust manifold is cast iron and includes a connection for the turbocharger. A moulded plastic acoustic cover is fitted over the upper engine to reduce engine-generated noise.

Engine Structure



E86216

Item	Part Number	Description
1	-	Camshaft carrier
2	-	Cylinder head
3	-	Cylinder block
4	-	Ladder frame
5	-	Oil pan

TECHNICAL FEATURES AND DATA

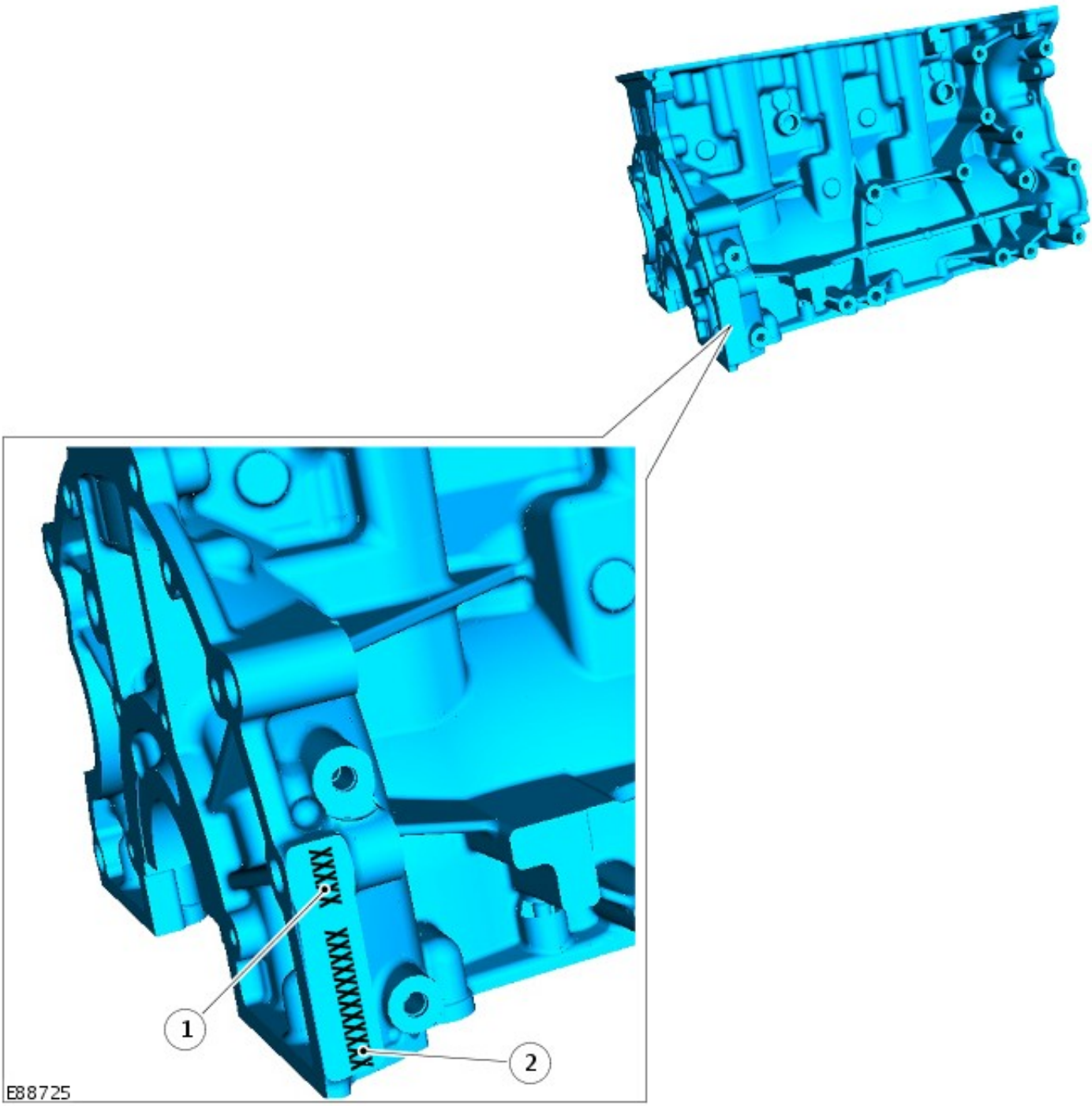
The technical features include:

- A 4 cylinder liquid cooled CGI cylinder block
- A light, high strength, aluminum cylinder head
- Four-valve technology with centrally arranged fuel injectors
- Steel roller rockers with hydraulic lash adjusters
- Variable geometry turbocharger
- Common rail direct fuel injection system
- High pressure injection fuel pump
- Gallery cooled pistons with a central crown bowl
- Electronically controlled water cooled EGR valve
- Exhaust re-treatment by means of a diesel-specific oxidation catalytic converter
- Cooling fan with electro-viscous clutch drive

Technical Data

Description	Specifications
Cubic capacity	2,402 ccm
Stroke	94.6 mm
Bore	89.9 mm
Compression ratio	19:1
Firing order	1-3-4-2
Idle speed	900 rpm
Max. power output	90 kW (122 PS) at 3,500 rpm
Max. torque	360 Nm at 2,000 rpm

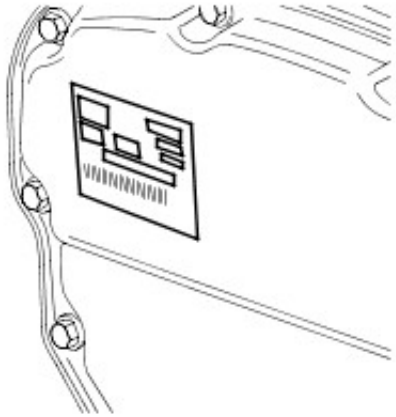
Engine Identification Code



Item	Part Number	Description
1	-	Engine code
2	-	Engine serial number

The engine serial number (12 digits) and engine code (5 digits) are stamped on the exhaust side of the cylinder block, parallel to the transmission clutch housing.

Engine Identification Plate



TIE0031810

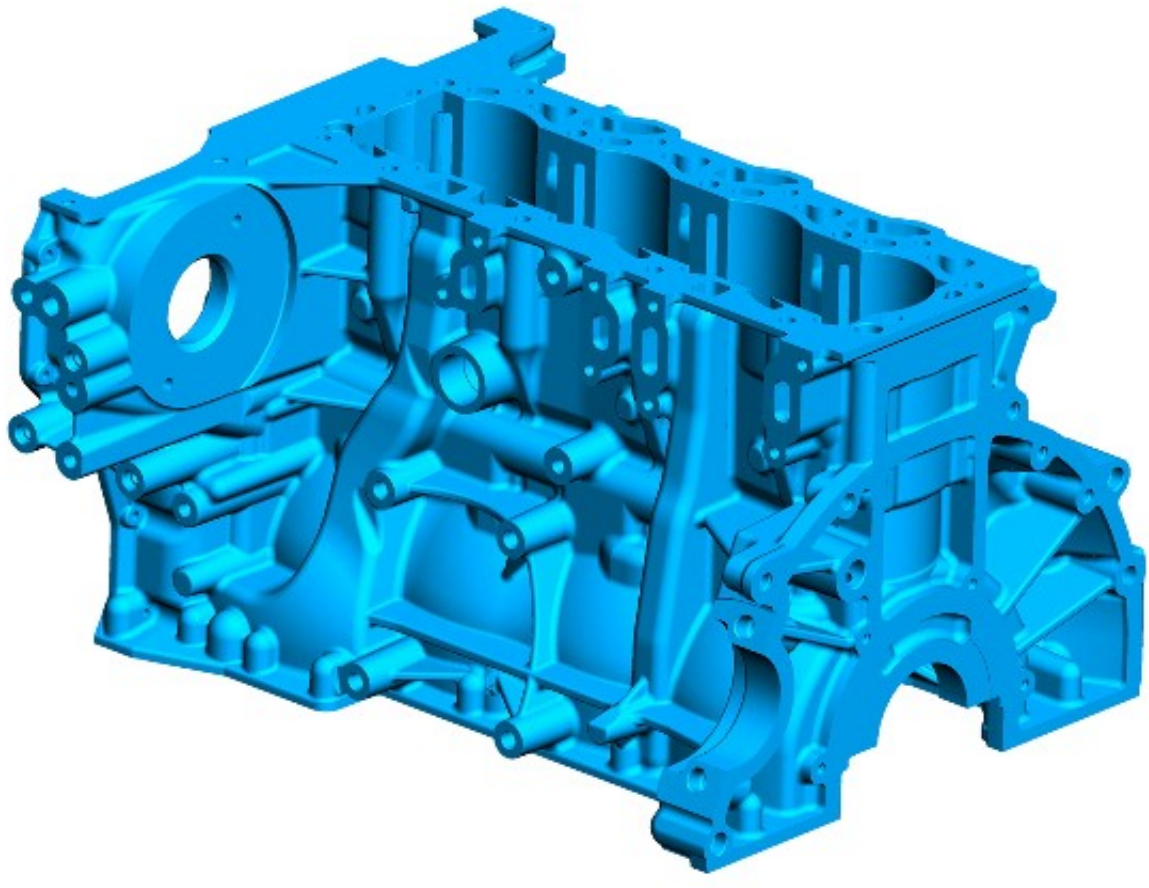
The engine identification plate is located on the cover of the timing cover. It contains the date and time of manufacture and the engine part number.

CYLINDER BLOCK COMPONENTS

The main cylinder block components are:

- The cylinder block
- Piston cooling jets
- Rear crankshaft oil seal and retainer
- Connecting rods and pistons
- Crankshaft Position (CKP) sensor
- Starter motor
- Generator
- Coolant and vacuum pump
- Power steering pump
- High-pressure fuel pump
- Coolant distribution manifold

Cylinder Block



E83340

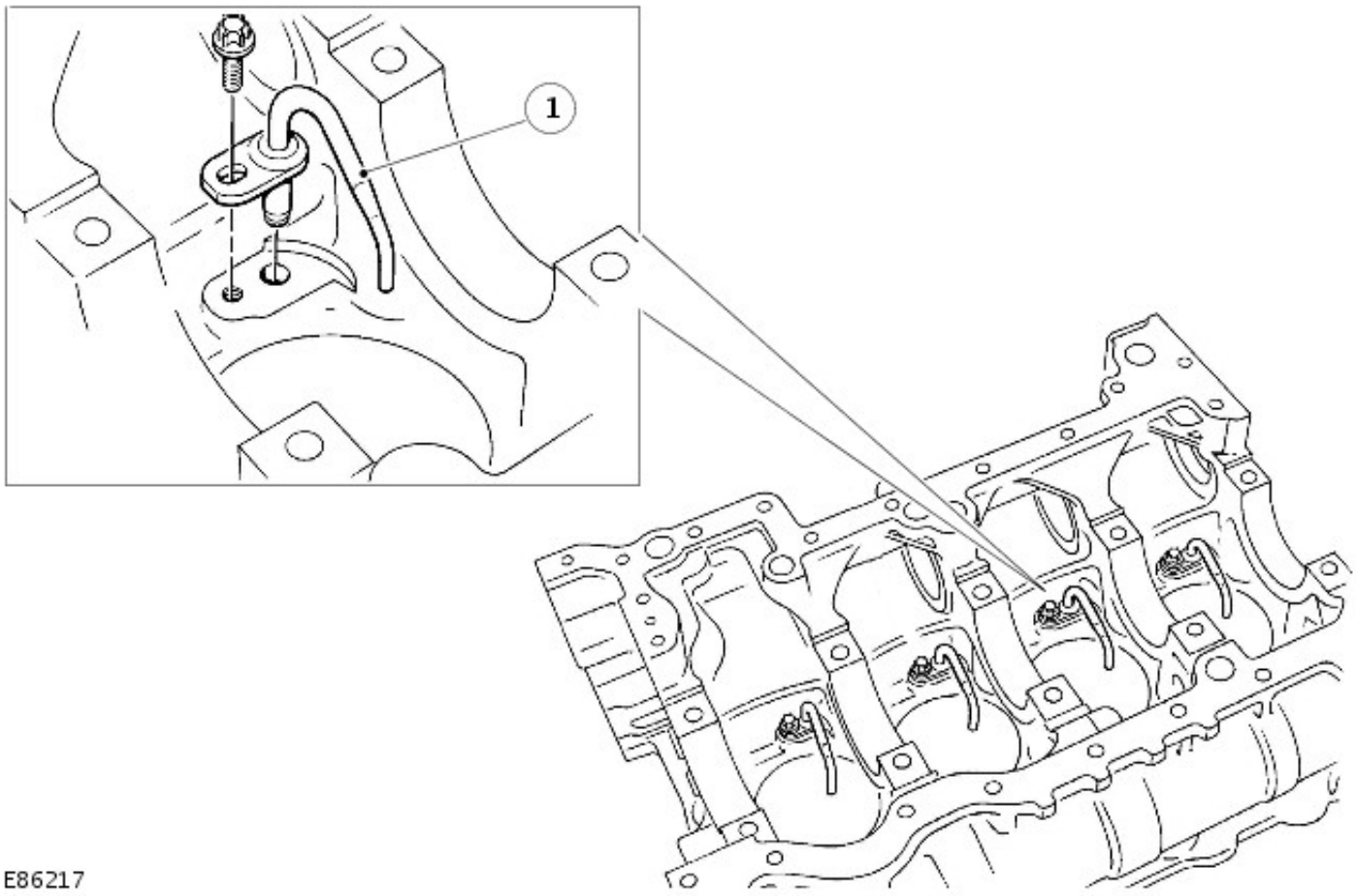
The cylinders and crankcase are contained in the cylinder block, which is of single cast CGI construction with a hollow beam structure. With this type of construction less material is required than for a conventional cast iron block, therefore, reducing engine weight and length.

The cylinder bores are machined directly in the block.

Three different bore diameters are used in production to ensure very precise adjustment of the clearance between the pistons and cylinders.

A turbocharger oil feed filter is located at number 1 journal to prevent debris from entering the turbocharger and damaging the bearings.

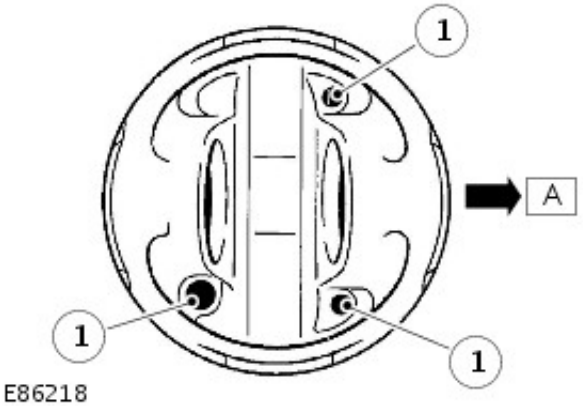
Piston Cooling Jets



E86217

Item	Part Number	Description
1	-	Piston cooling jet

Jets located in the cylinder block provide piston and piston pin lubrication and cooling. These jets spray oil on to the inside of the piston, the oil then flows through an internal wave shaped oil cooling channel to help cool each piston crown.

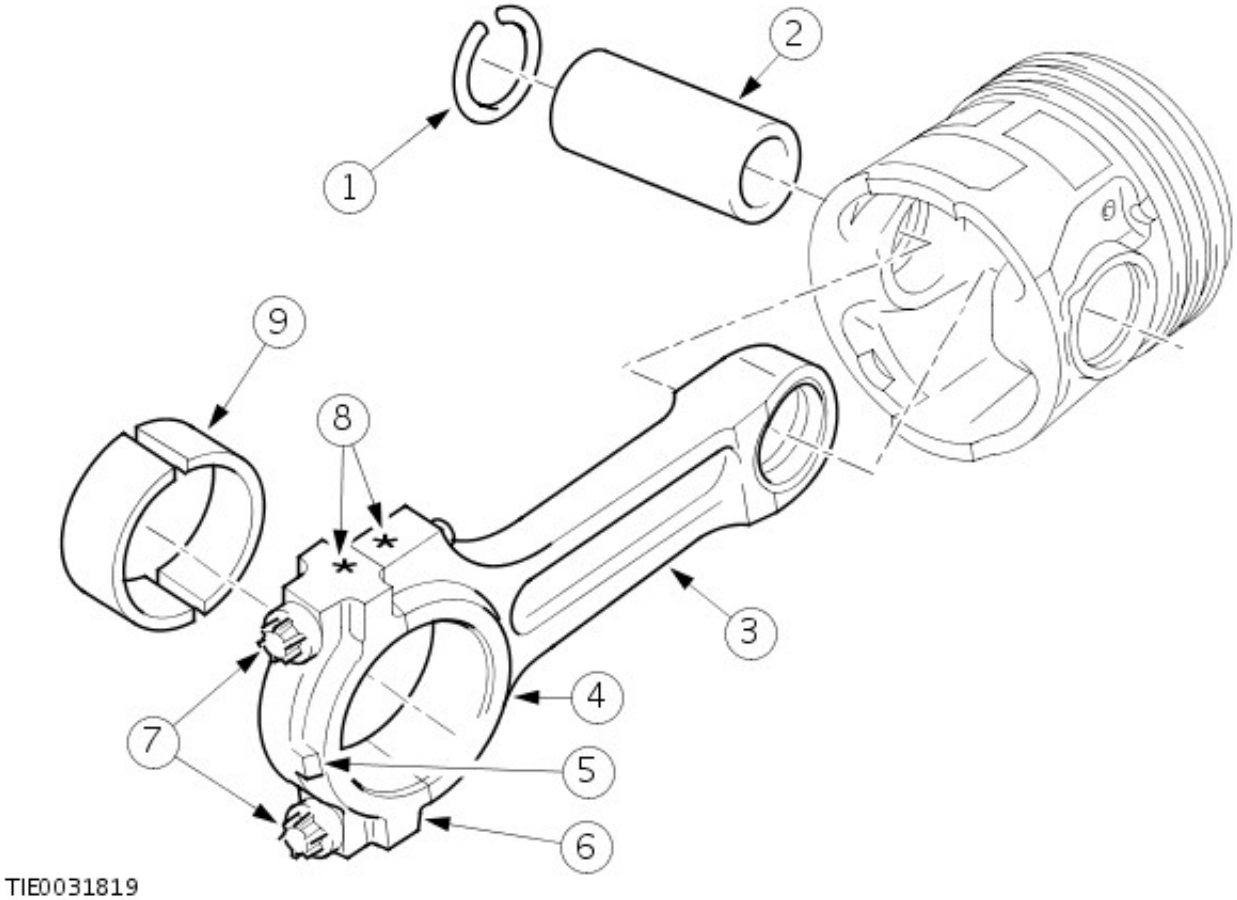


E86218

Item	Part Number	Description
A	-	Front of the engine
1	-	Oil cooling channels

Lubrication oil is distributed through the cylinder block, via the main oil gallery and channels bored in the block, to all critical moving parts. These channels divert oil to the main and big-end bearings via holes machined into the crankshaft.

Connecting Rods and Pistons

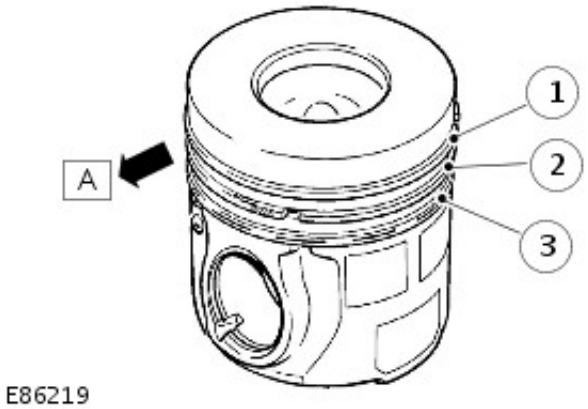


TIE0031819

Item	Part Number	Description
1	-	Circlip
2	-	Piston pin
3	-	Connecting rod
4	-	Connecting rod bearing
5	-	Projection
6	-	Bearing cap
7	-	Retaining bolts
8	-	Identification
9	-	Bearing shell

The connecting rods are manufactured from sinter-forged steel. The selective connecting rod bearings are aluminum/tin split plain bearings. The connecting rod bearing is 'sputter coated', which is a manufacturing process that layers the bearing material to produce a higher load capacity for improved durability.

The connecting rods are available in 3 different lengths. For identification, the connecting rod and bearing cap are marked with the corresponding identification code.



E86219

Item	Part Number	Description
A	-	Front of the engine
1	-	Upper compression ring

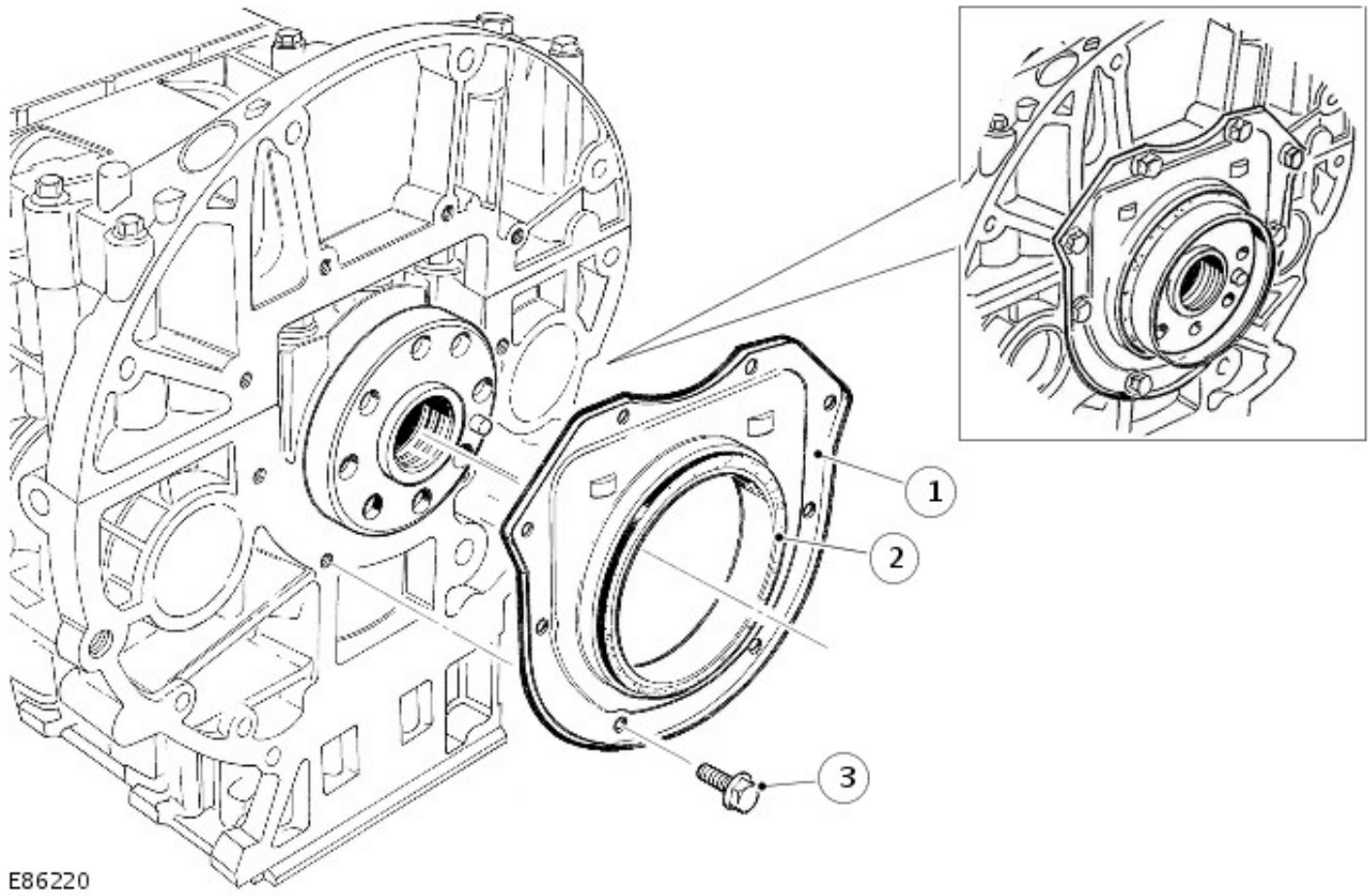
2	-	Lower compression ring
3	-	Oil control ring

The pistons are made from aluminum alloy and are fitted with three rings. The piston crown incorporates a pronounced bowl; this forms the combustion chamber, which promotes swirl and turbulence necessary for good combustion and improved emissions. In addition, the piston also incorporates oil cooling galleries within the piston crown to enhance piston cooling (see piston cooling jets section for more information).

When installing pistons ensure the arrows on the piston crowns all point to the front of the engine.

Each piston is installed on a wrist pin located in an aluminum/tin bushing in the connecting rod.

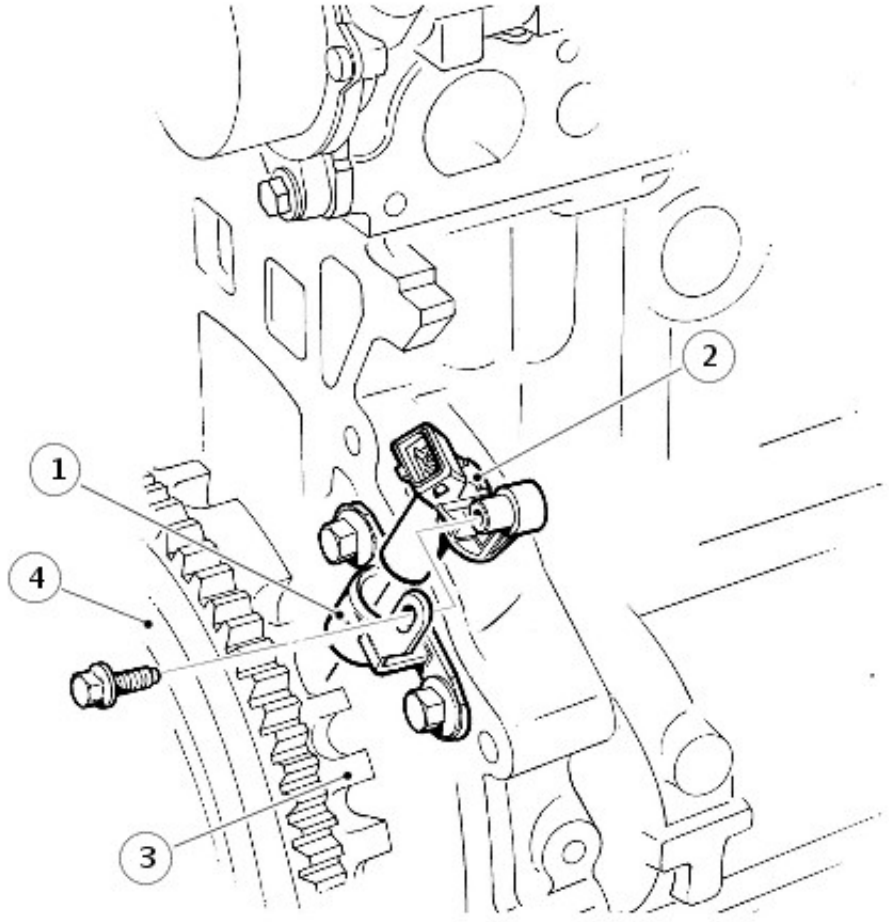
Rear Oil Seal Retainer



Item	Part Number	Description
1	-	Rear oil seal retainer
2	-	Rear oil seal
3	-	Bolt (8 off)

The crankshaft rear oil seal retainer is attached to the rear of the cylinder block by 8 bolts and is sealed with a rubber seal.

Crankshaft Position (CKP) Sensor

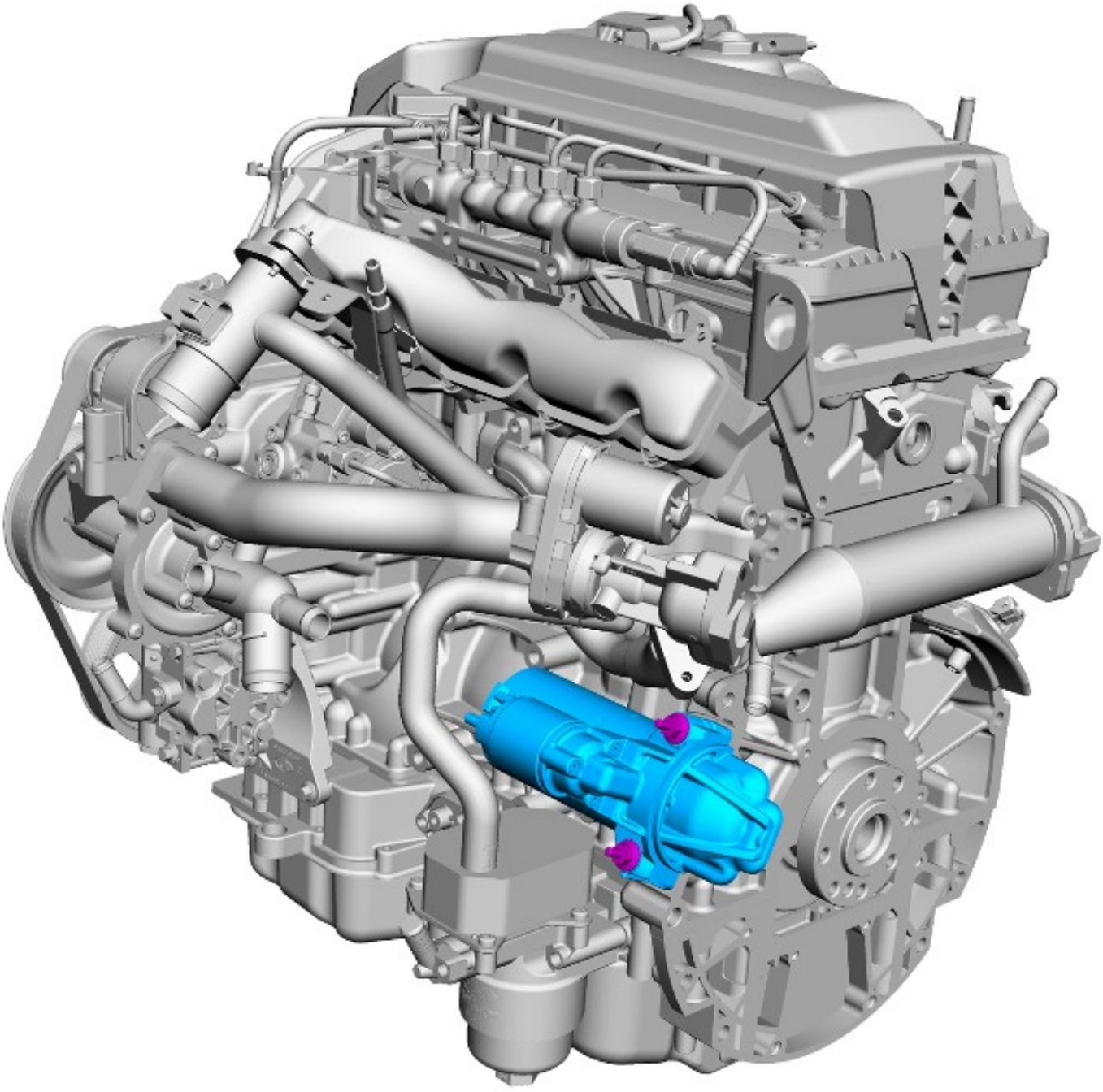


E86221

Item	Part Number	Description
1	-	CKP mounting bracket
2	-	CKP sensor
3	-	Trigger wheel (reluctor)
4	-	Flywheel

The CKP sensor is located on the cylinder block and transmission flange. The sensor provides an input of engine crankshaft speed and position. The sensor works on the Hall effect principle and scans a trigger wheel on the back of the flywheel. If the CKP sensor bracket has been removed it is important it is aligned correctly when fitting.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

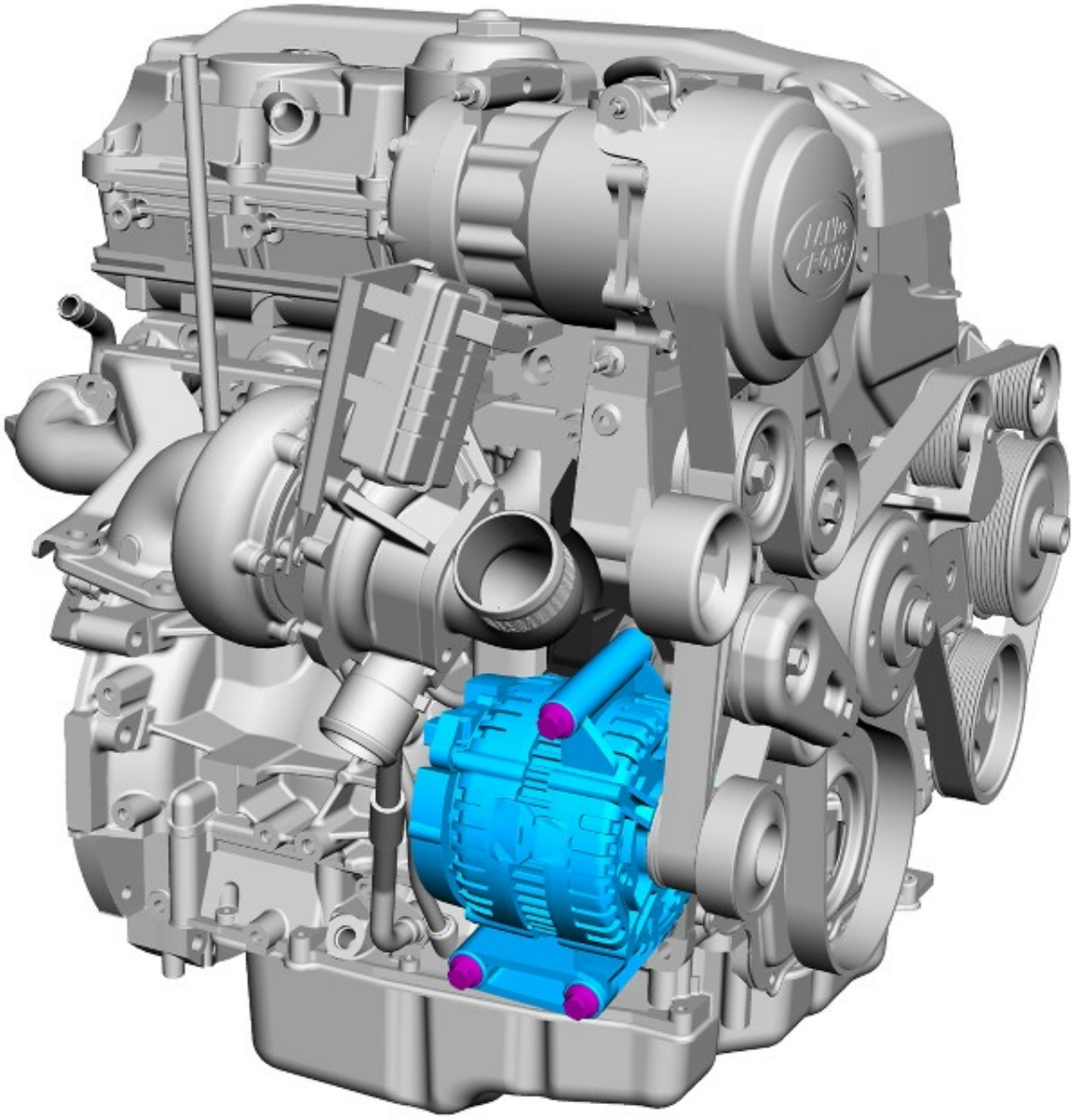
Starter Motor



E86222

The engine starter motor is installed at the rear Left Hand (LH) side of the cylinder block, on the transmission flange. For additional information, refer to: Starting System (303-06 Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Generator

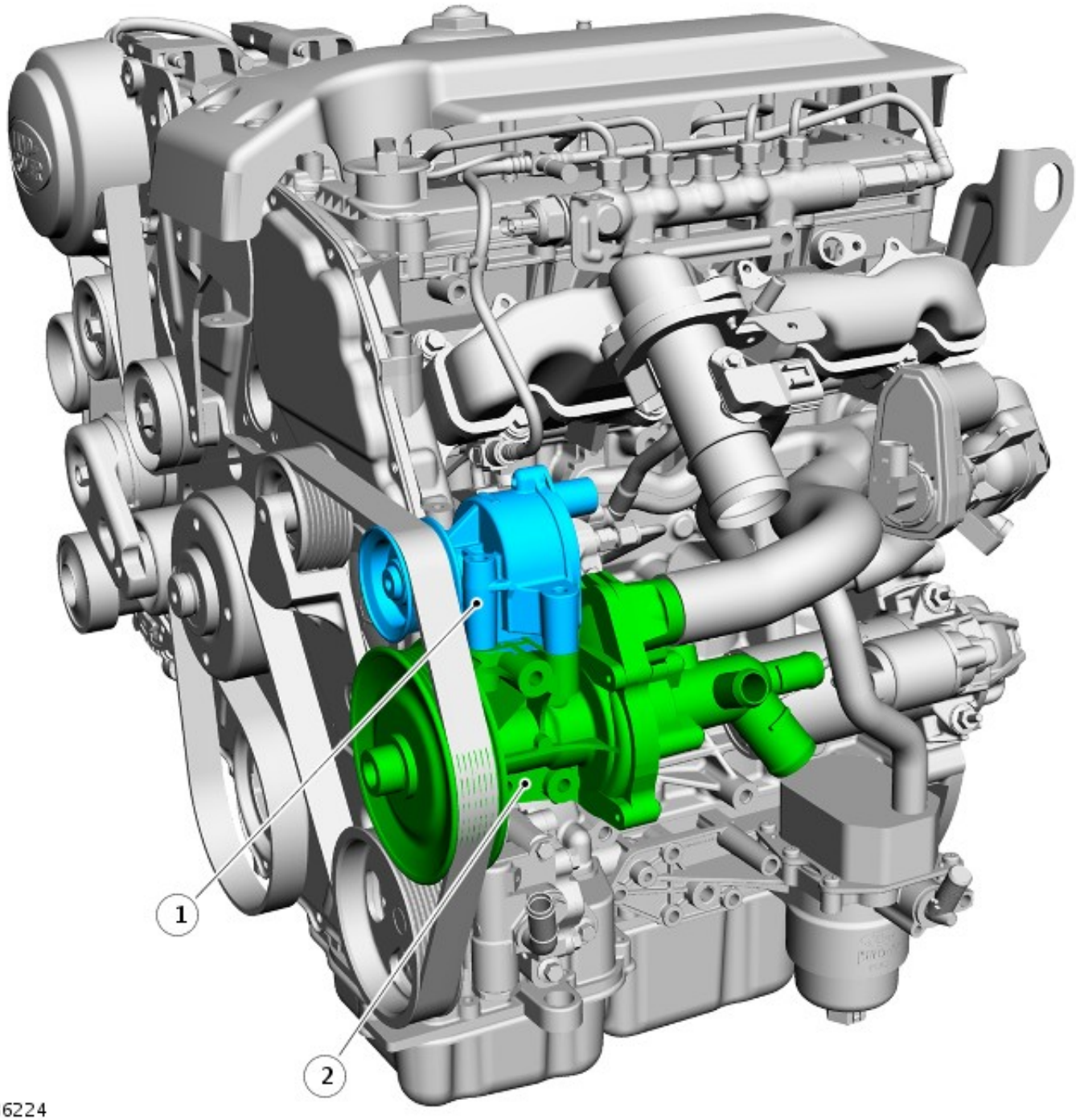


E86223

Item	Part Number	Description
1	-	Generator mounting bracket
2	-	Generator

The generator is located at the front Right Hand (RH) side of the engine on a mounting bracket, which is bolted to the cylinder block. The accessory drive belt drives the generator pulley, which in turn is driven from the engine crankshaft pulley.
For additional information, refer to: Generator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Coolant Pump and Vacuum Pump



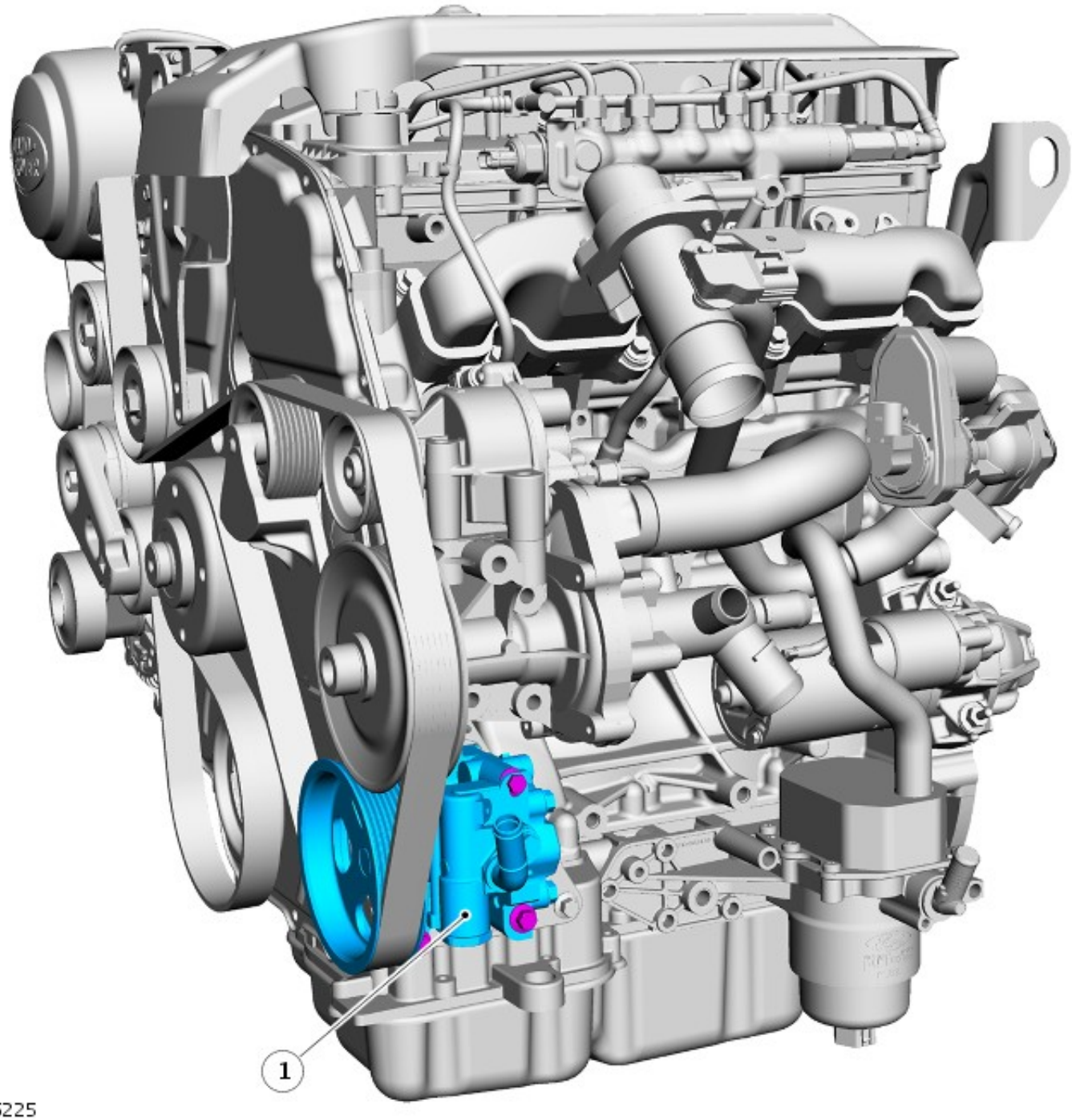
E86224

Item	Part Number	Description
1	-	Vacuum pump
2	-	Coolant pump

The coolant pump is installed at the front, LH side of the cylinder block and is secured with 4 bolts. The coolant pump is driven by the accessory drive belt via the crankshaft. The engine thermostat is located in the rear of the coolant pump housing and begins to open at 88°C (190°F).
For additional information, refer to: Engine Cooling (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

The vacuum pump is mounted on top of the cooling pump and is secured with 3 bolts. The vacuum pump is also driven by the accessory drive belt via the crankshaft.

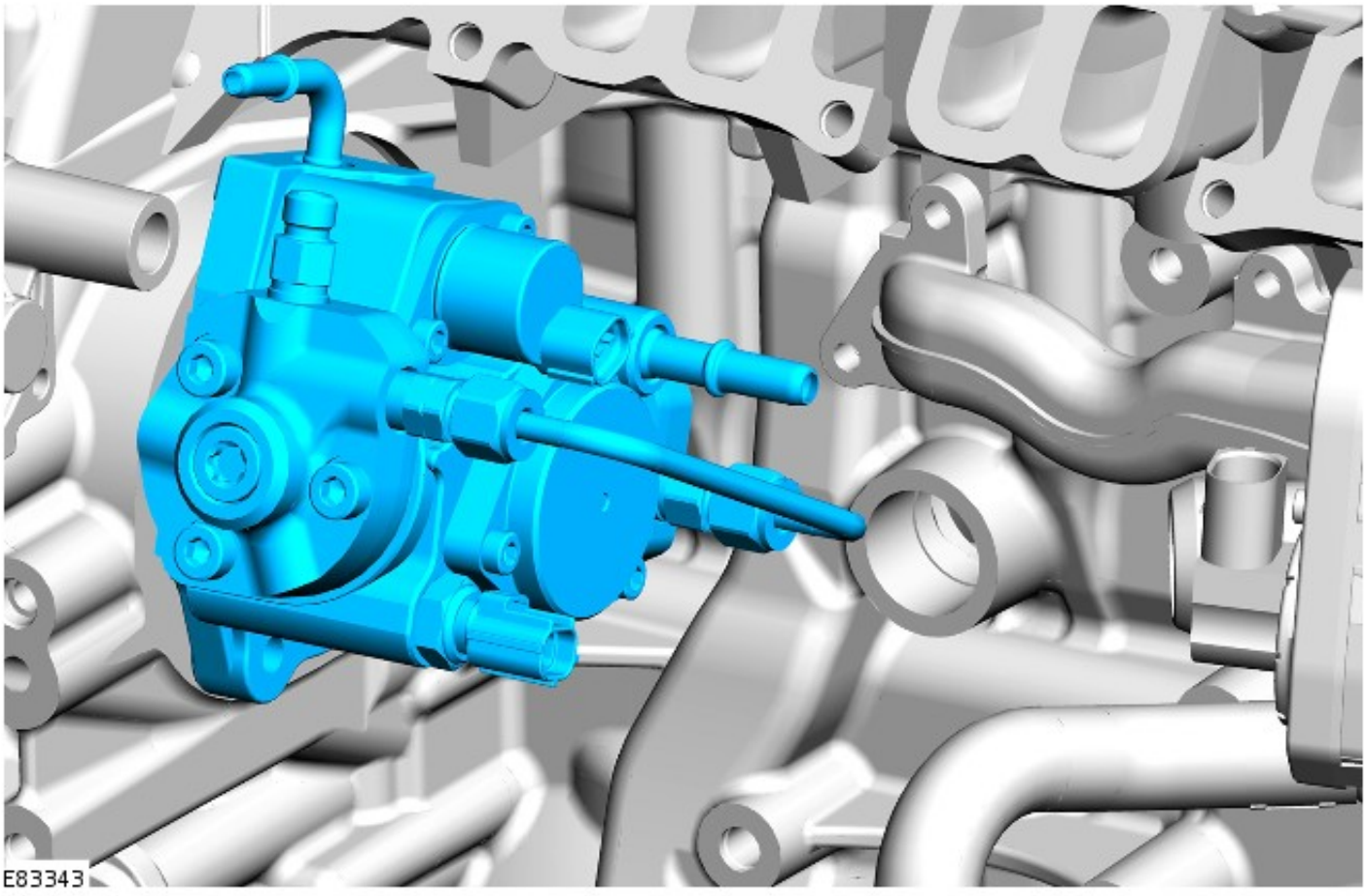
Power Steering Pump



Item	Part Number	Description
1	-	Power steering pump

The power steering pump is located at the front, LH side of the cylinder block, directly below the coolant pump. The power steering pump is attached to a mounting bracket via 3 bolts and the mounting bracket locates on the cylinder block and ladder frame via 4 bolts.
For additional information, refer to: Power Steering (211-02 Power Steering, Description and Operation).

High-Pressure Fuel Pump



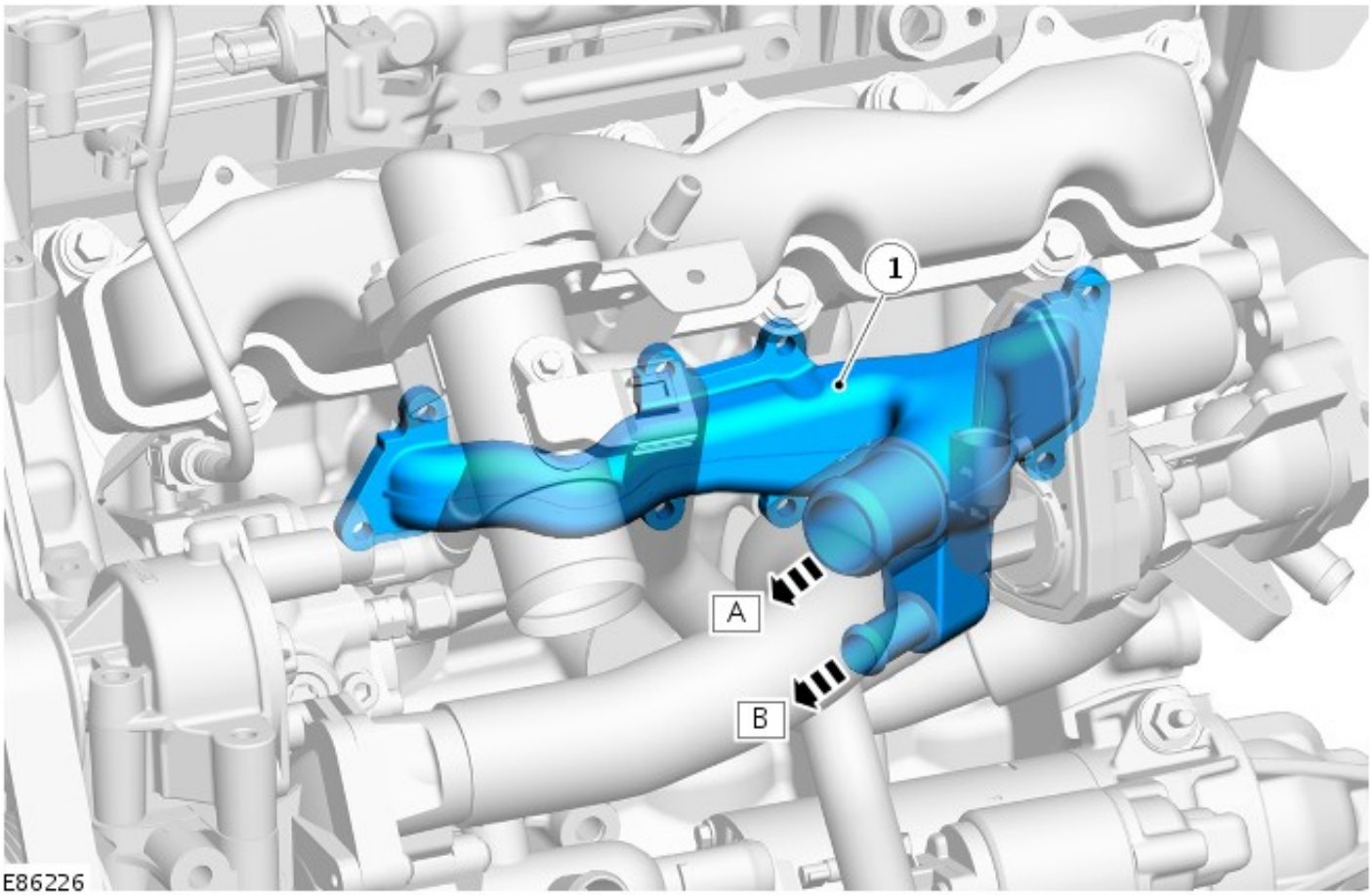
The high-pressure fuel pump is located under the intake manifold, behind the coolant and vacuum pump assembly. The fuel pump is driven by the timing chain at the front of the engine and includes a transfer pump and a high pressure pump which are serviced as one unit.

The pump provides the interface between the low and high-pressure systems. Its function is to always provide sufficient compressed fuel under all operating conditions and for the entire service life of the vehicle.

The transfer pump draws the fuel from the fuel tank, through the fuel filter, and then pumps the fuel to the high-pressure pump. The transfer pump maintains a constant fuel pressure through a regulating valve within the fuel pump; this is known as transfer pressure.

The high-pressure pump receives fuel at transfer pressure from the transfer pump and increases the fuel pressure. The high pressure fuel is then transferred from the high-pressure pump to the common rail.
For additional information, refer to: Fuel Charging and Controls (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Coolant Distribution Manifold



Item	Part Number	Description
A	-	Coolant pump connection
B	-	Engine oil cooler connection
1	-	Coolant distribution manifold

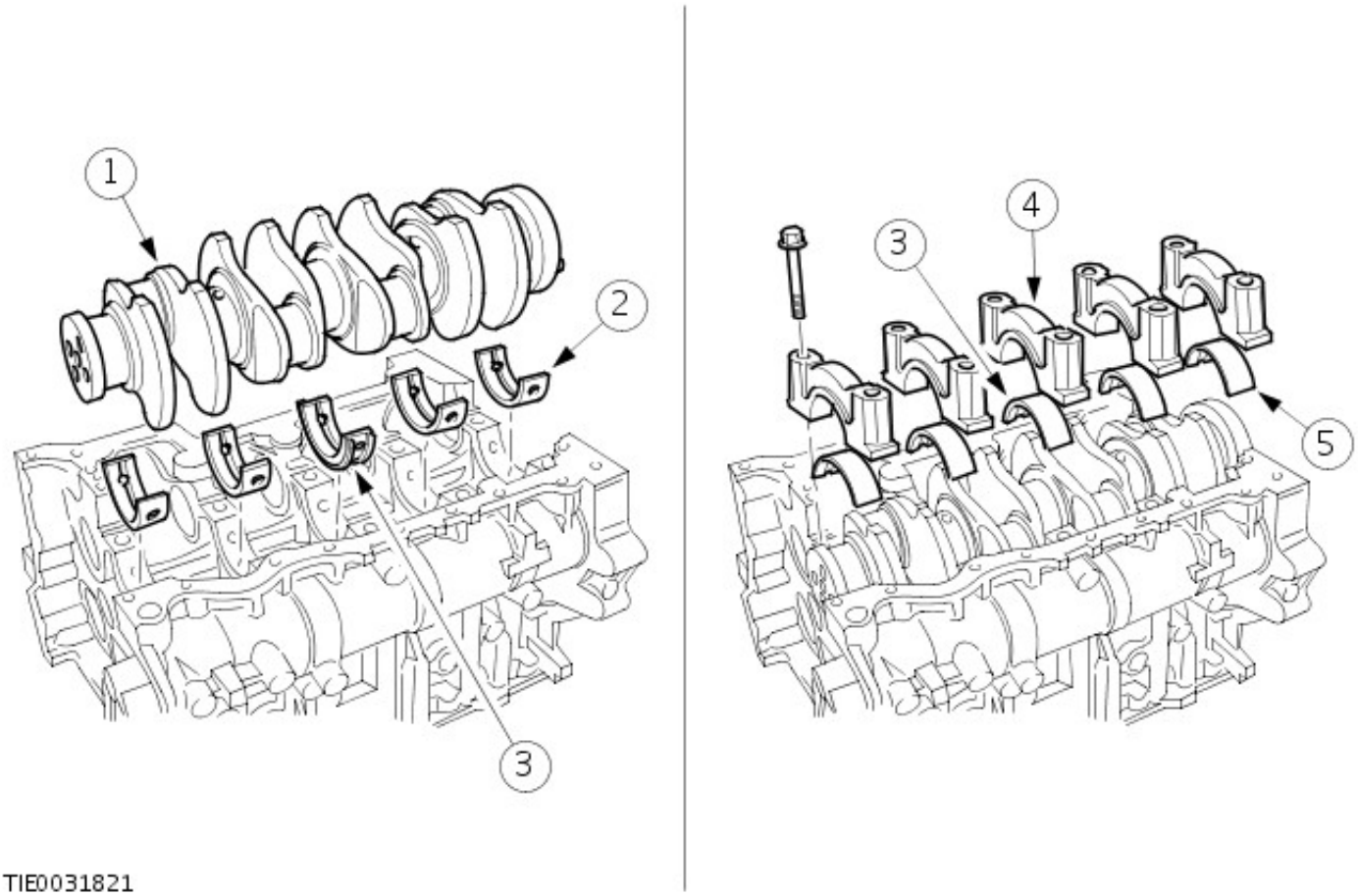
The coolant distribution manifold is located on the LH of the cylinder block, just below the intake manifold. The manifold receives coolant from the coolant pump and distributes it to the cylinder block and the engine oil cooler.

CRANKSHAFT AND SUMP COMPONENTS

The main crankshaft and sump components are:

- The crankshaft and main bearings
- Ladder frame and sump
- Oil filter and engine cooler assembly

Crankshaft and Main Bearings



TIE0031821

Item	Part Number	Description
1	-	Crankshaft
2	-	Upper main bearing shell
3	-	Upper main bearing shell (No.3 is a thrust bearing)
4	-	Bearing cap
5	-	Lower main bearing shell

The crankshaft is forged steel and fillet rolled with induction hardened journals, which run in 5 bearings with clamped 2 layer bearing shells.

The crankshaft drive pulley is not keyed onto the crankshaft; it is secured to the crankshaft by a single bolt.

The main bearing caps are double and cross-bolted, this adds to the strength and rigidity of the engine block.

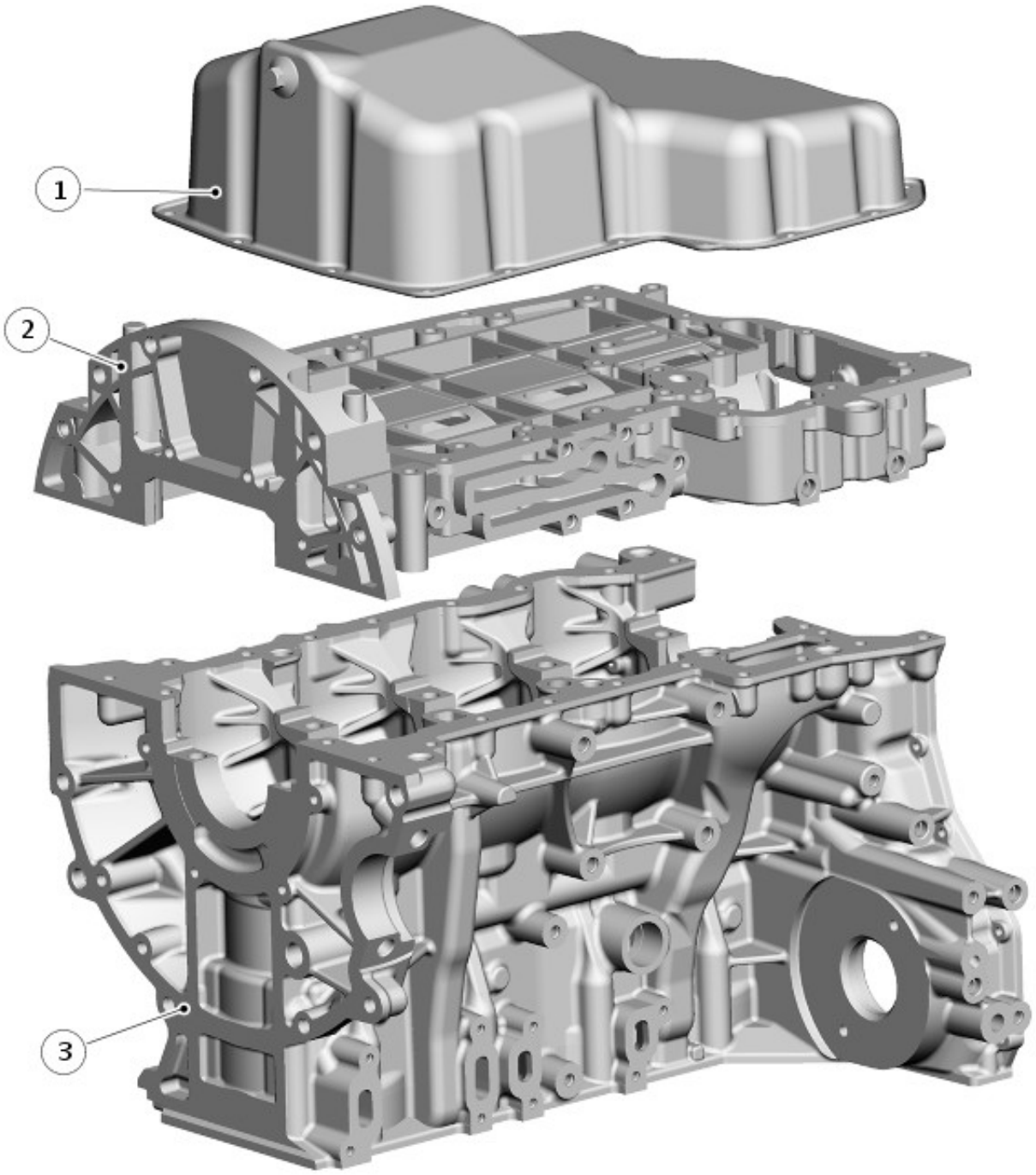
The main bearings are aluminum/tin split plain selective bearings. An oil groove in the top half of each bearing transfers oil into the crankshaft for lubrication of the connecting rod bearings. The upper and lower shells of bearing number 3 contain integral thrust washers, which limits the end float of the crankshaft.

The arrow on the bearing caps must point towards the front of the engine and are identified as follows:

Bearing cap	Identification
1	F (front)
2	2
3	3
4	4
5	R (rear)

The crankshaft front and rear oil seals are a press fit in the oil seal retainers.

Ladder Frame and Sump



E86227

Item	Part Number	Description
1	-	Oil pan
2	-	Ladder frame
3	-	Cylinder block

The aluminum alloy ladder frame is fitted to the lower cylinder block to stiffen the base structure of the engine thus helping to reduce Noise, Vibration and Harshness (NVH). The frame is made of high-pressure die cast aluminum and also incorporates an oil baffle plate to reduce oil foaming and splash.

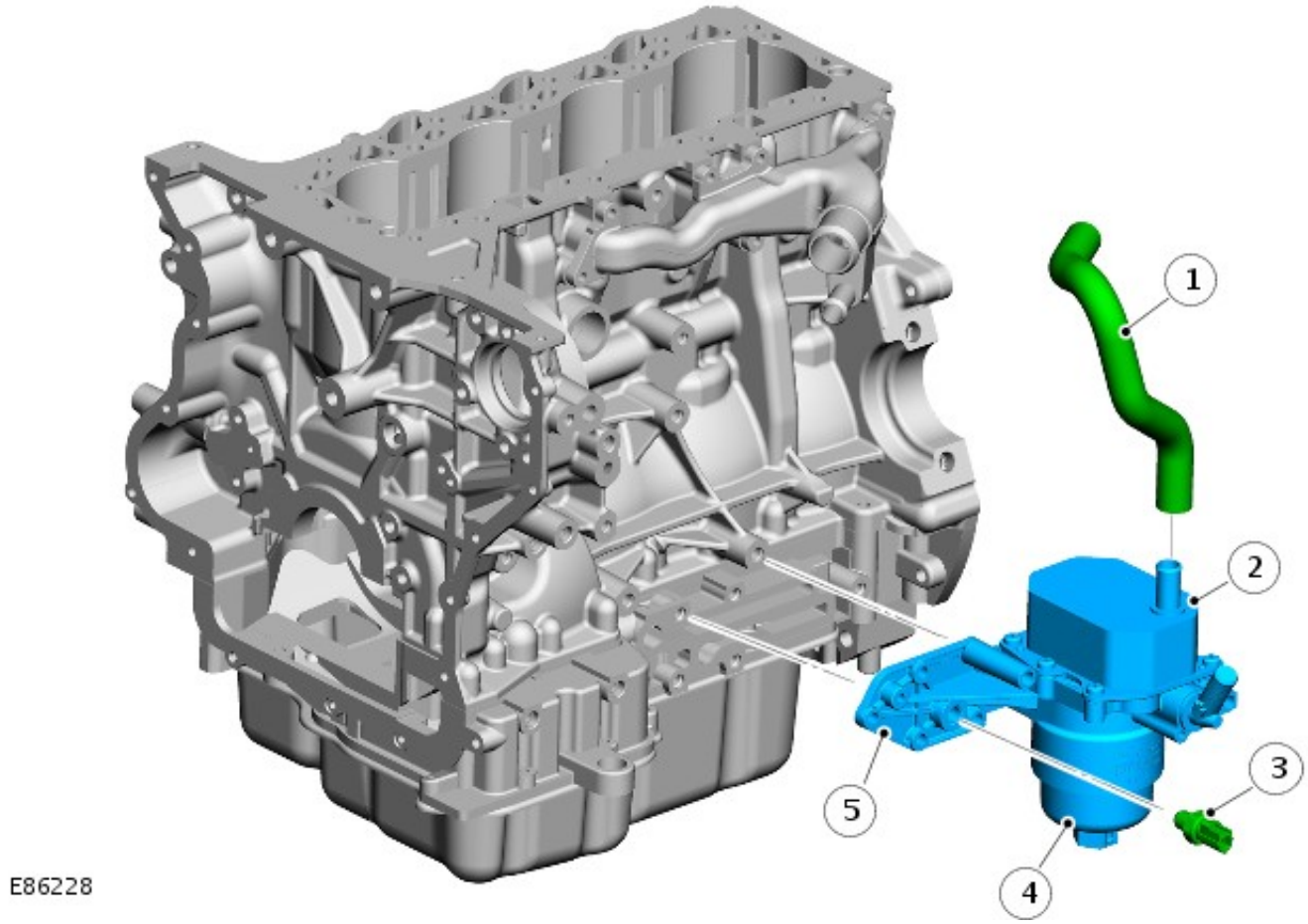
The ladder frame and the cylinder block side clearance must be aligned using a special tool. The rear clearance must be aligned using a suitable straight edge (for more information refer to the workshop repair manual).

The ladder frame is secured to the cylinder block with 22 retaining bolts. The pressed steel oil pan is bolted to the ladder frame with 16 bolts. The engine oil drain plug is located at the rear face of the oil pan and the oil level/temperature sensor is located at the RH side of the ladder frame, behind the turbocharger oil drain tube.

The engine oil pump is bolted to the underside of the ladder frame at the front LH side and is driven by a sprocket on the crankshaft via a dedicated chain (for more information refer to the lubrication section).

A reusable gasket seals the joint between the oil pan and the ladder frame; a bead of sealant seals the joint between the sump and the ladder frame.

Oil Filter and Engine Oil Cooler Assembly



Item	Part Number	Description
1	-	Hose - coolant distribution manifold to oil cooler
2	-	Oil cooler
3	-	Oil pressure switch
4	-	Oil filter
5	-	Mounting plate

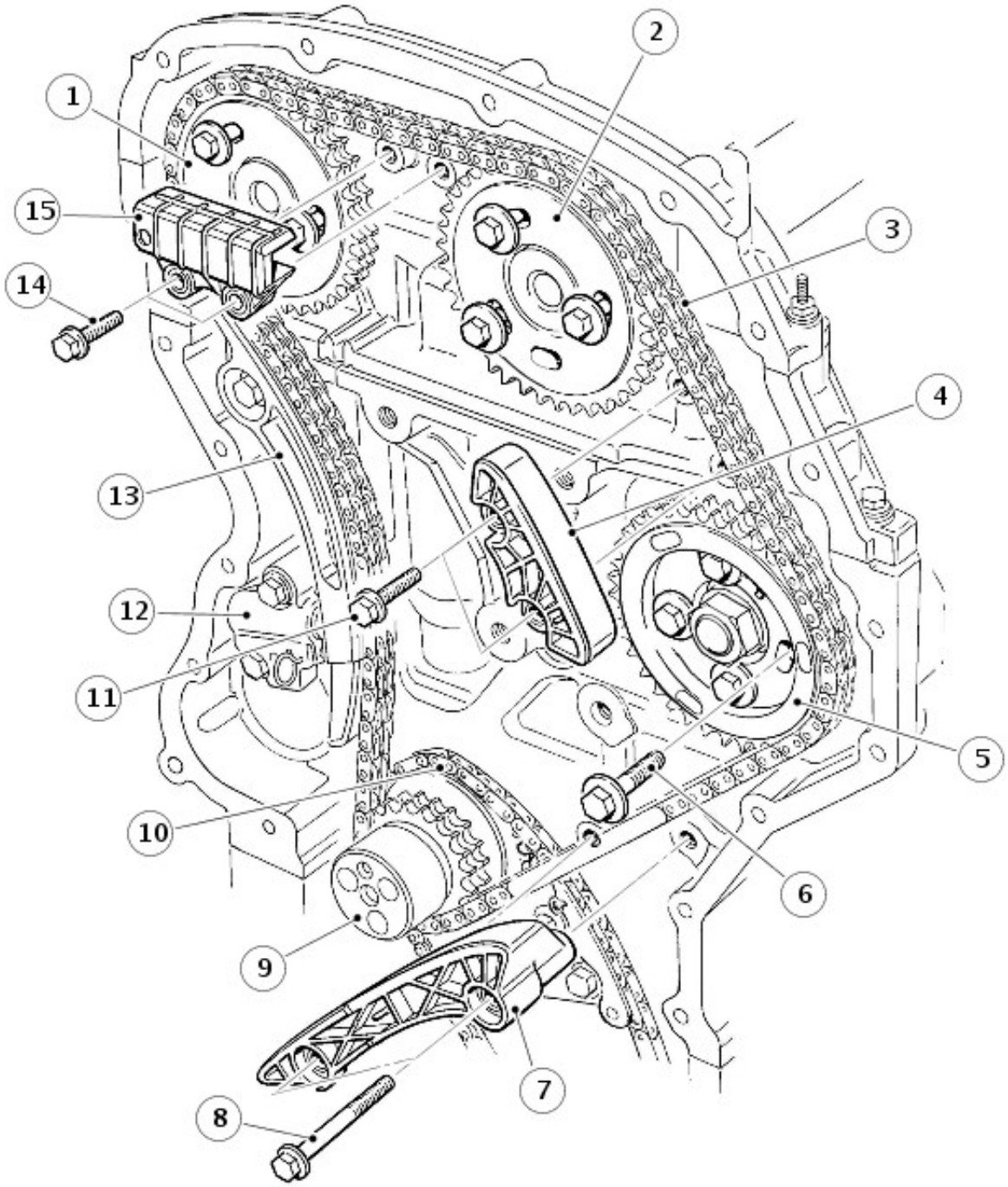
The oil filter and engine oil cooler assembly is mounted to the LH side of the ladder frame with 6 bolts. The oil pressure switch locates through the oil filter and engine oil cooler assembly mounting plate and into the ladder frame (for more information refer to the lubrication section).

CAMSHAFT DRIVE COMPONENTS

The main camshaft drive components are:

- Drive gear assembly
- Front cover

Drive Gear



E86229

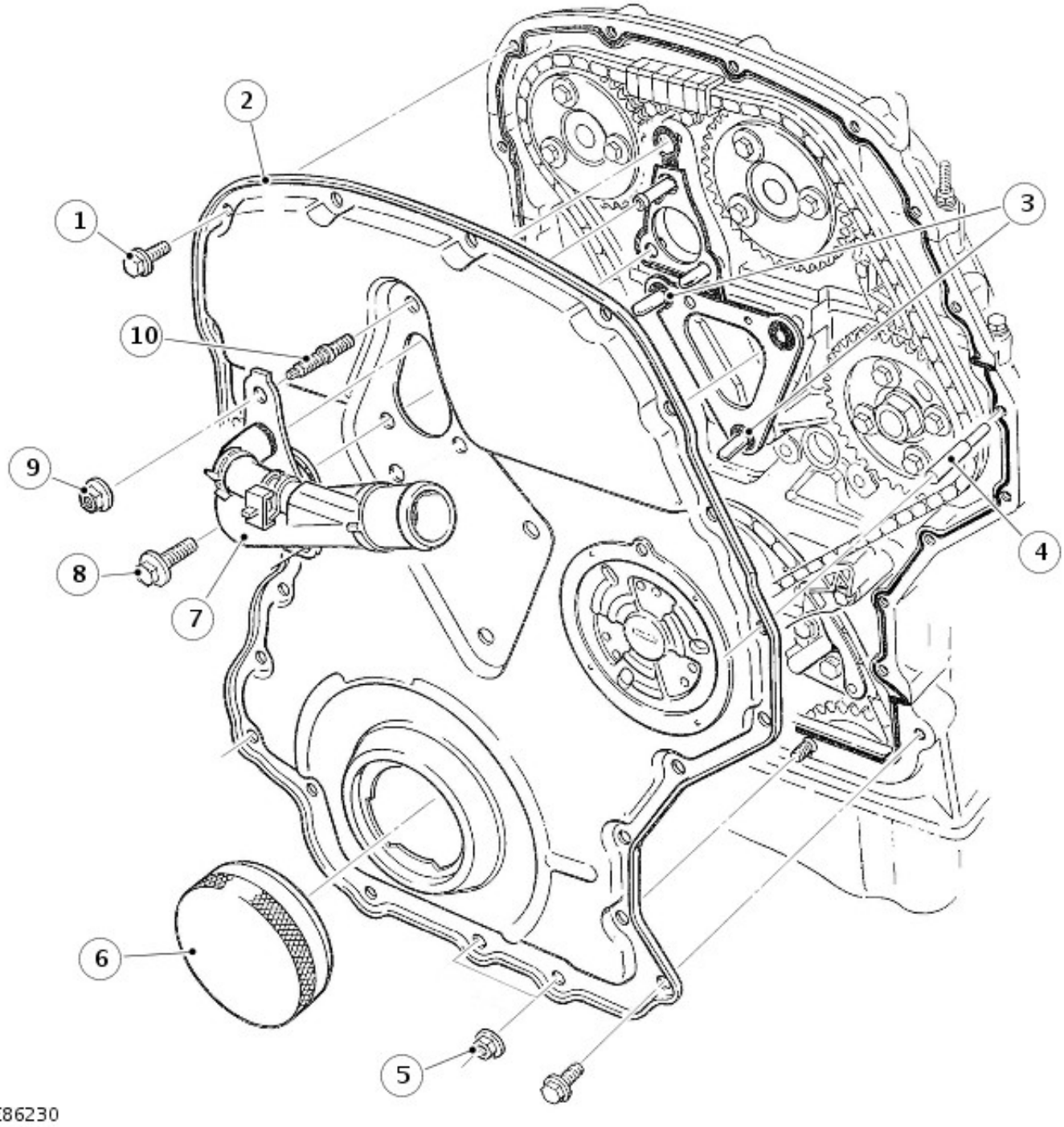
Item	Part Number	Description
1	-	Exhaust camshaft sprocket
2	-	Inlet camshaft sprocket
3	-	Primary drive chain
4	-	Primary drive chain guide
5	-	High-pressure fuel injection pump sprocket
6	-	Bolt (4 off)
7	-	Primary drive chain guide
8	-	Bolt (2 off)
9	-	Crankshaft sprocket
10	-	Secondary drive chain
11	-	Bolt (2 off)
12	-	Automatic tensioner
13	-	Primary drive chain tensioner arm
14	-	Bolt (4 off)
15	-	Primary drive chain guide

A multiple link primary drive chain transmits the drive from the sprocket on the crankshaft to the exhaust camshaft, the inlet camshaft and the high-pressure fuel pump. The secondary drive chain transmits drive from the sprocket on the crankshaft to the oil pump located on the underside of the ladder frame.

One bolt locates the drive sprocket on the crankshaft and 3 bolts are used to mount the crankshaft's torsional vibration damper to the crankshaft via holes in the drive sprocket. The inlet and exhaust camshaft sprockets are aligned on their respective camshafts using a spigot tool and a timing peg. Once they are in their correct position, 3 bolts are used to secure each camshaft sprocket to their camshaft.

Each chain has a hydraulic tensioner operated by engine oil. The primary chain is lubricated via an oil squirt tube located centrally at the front of the engine block. Oil from the ladder frame and oil pan assembly splash lubricates the secondary chain. The primary chain tensioner acts on a pivoting flexible tensioner blade. The secondary chain tensioner acts directly on the chain. Guide rails are installed on the drive side of the primary chains.

Front Cover



Item	Part Number	Description
1	-	Bolt (20 off)
2	-	Front cover
3	-	Locating pins
4	-	Guide pin
5	-	Nut (2 off)
6	-	Alignment tool
7	-	Water outlet
8	-	Bolt (2 off)

9	-	Nut
10	-	Stud

The pressed steel front cover is bolted to the front of the cylinder block, the cylinder head and the ladder frame with 20 bolts and sealed with a bead of Room Temperature Vulcanizing (RTV) silicon sealant.

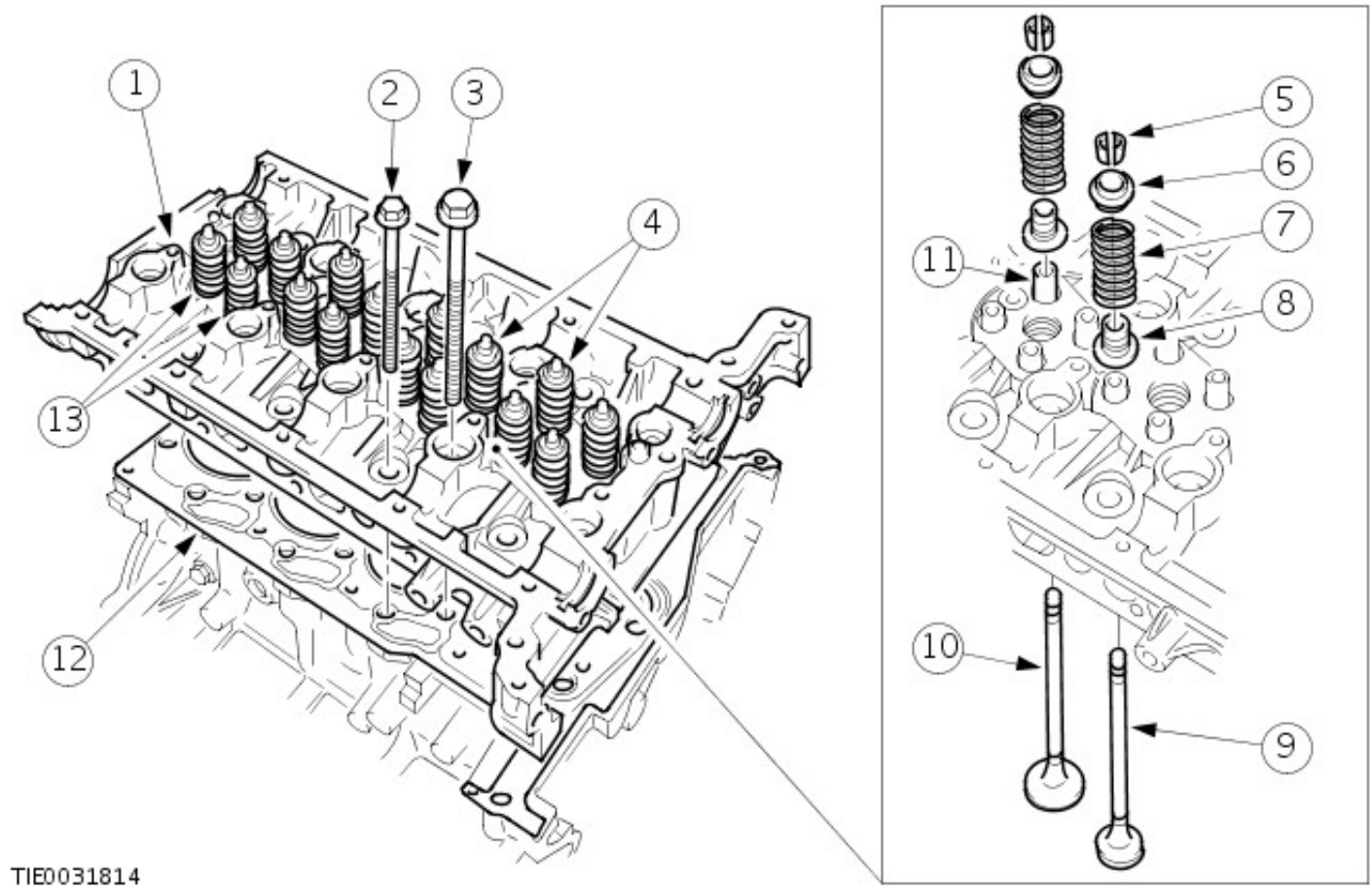
When installing the front cover, a special locating tool is required, which fits in the crankshaft sprocket aperture, to aid the alignment of the front cover.

CYLINDER HEAD COMPONENTS

The main cylinder head components are:

- Cylinder head and valves
- Camshafts
- Cylinder head gasket
- Glow plugs
- Fuel injectors
- Cylinder Head Temperature (CHT) sensor
- High-pressure fuel rail
- Inlet manifold
- Exhaust manifold
- Camshaft carrier
- Hydraulic lash adjusters
- Camshaft Position (CMP) sensor
- Camshaft and engine cover

Cylinder Head and Valves



TIE0031814

Item	Part Number	Description
1	-	Cylinder head
2	-	Outer cylinder head bolt (8 off)
3	-	Inner cylinder head bolt (10 off)
4	-	Intake valves (16 off)
5	-	Valve collets (32 off)
6	-	Spring retainer (16 off)
7	-	Valve spring (16 off)
8	-	Valve stem oil seal (16 off)
9	-	Exhaust valve (8 off)
10	-	Intake valve (8 off)

11	-	Valve guide (16 off)
12	-	Cylinder head gasket
13	-	Valve assembly

The cylinder head is made of gravity die cast aluminum. Four valves per cylinder provides improved cylinder charging, a compact combustion chamber, and vertical fuel injectors guarantee optimum distribution of the fuel in the combustion chamber.

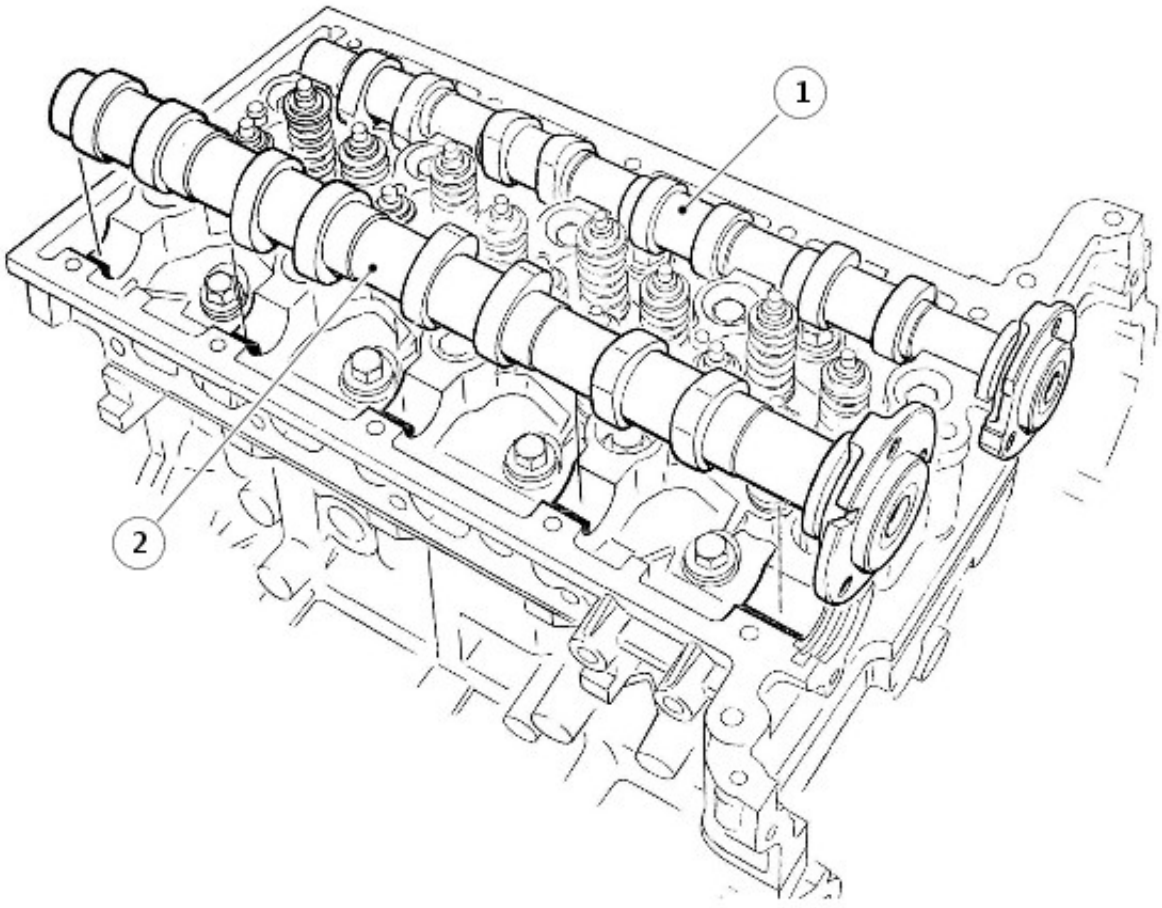
Eighteen deep-seated bolts help reduce distortion and secure the cylinder head to the cylinder block. The 8 cylinder head outer bolts are shorter than the inner bolts and are located beneath the camshafts, 4 under the inlet camshaft and 4 under the exhaust camshaft. Two hollow dowels align each cylinder head with the cylinder block.

The cylinder head has four ports machined at each cylinder location, 2 exhaust ports and 2 inlet ports. One of the inlet ports is helical and functions as a swirl port, the other is arranged laterally as a tangential port and functions as a charge port.

• NOTE: The cylinder head cannot be reworked.

All valves are supported in sintered metal seats and guide inserts. Collets, valve collars and spring seats locate single valve springs on both intake and exhaust valves. Valve stem seals are integrated into the spring seats.

Camshafts

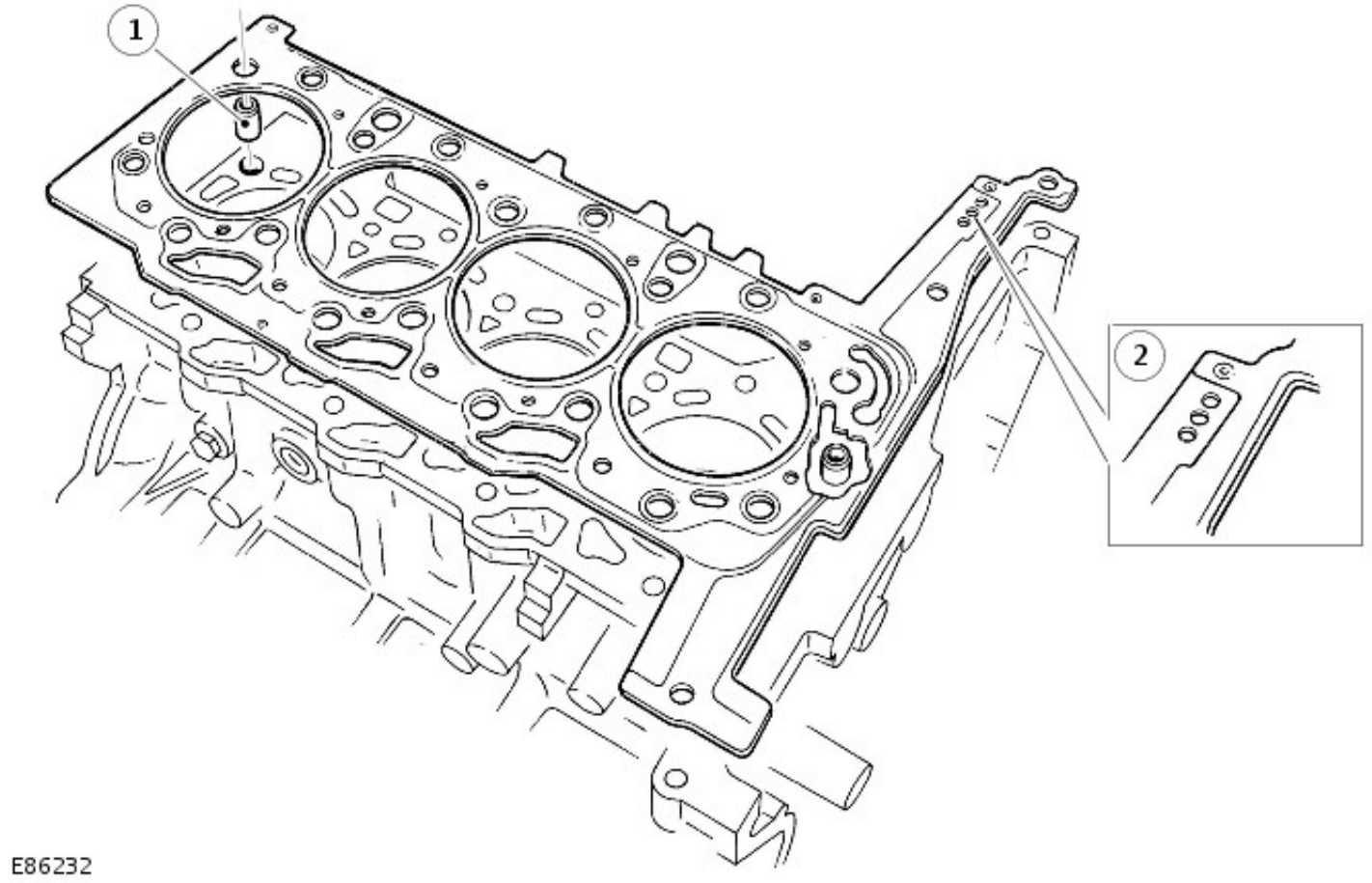


E86231

Item	Part Number	Description
1	-	Inlet camshaft
2	-	Exhaust camshaft

The camshafts are of a hollow steel tube construction, with pressed on sintered lobes and have a machined face at the front to accept the camshaft gear sprocket. The camshafts are retained in the cylinder head by the camshaft carrier. The reluctor, machined towards the rear of the inlet camshaft, enables the Camshaft Position (CMP) sensor to provide a signal, which enables the ECM to determine the position of the camshaft relative to the crankshaft.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Cylinder Head Gasket



Item	Part Number	Description
1	-	Locating bush (2 off)
2	-	Identification holes

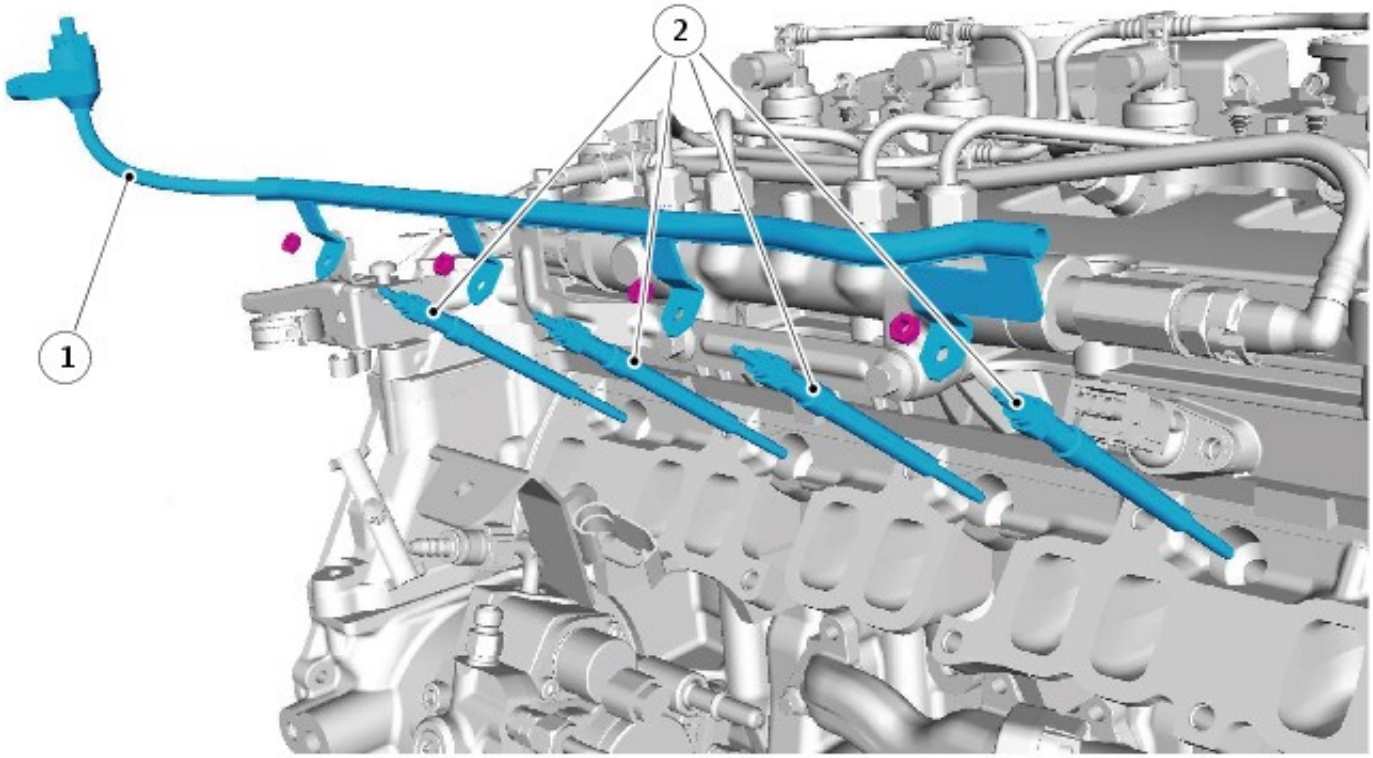
The cylinder head gasket is a 4-layer, laminated steel type and is available in 3 different thicknesses. The choice of gasket thickness is dependent on the maximum piston protrusion. Gasket thickness is identified by holes in the front end of the gasket.

Two locating bushes are fitted in the cylinder block to centre the cylinder head gasket.

• NOTE: If a cylinder head gasket is being changed only use a new gasket with the same identification markings. If new pistons or connecting rods are fitted, measure the maximum piston protrusion height and select the appropriate gasket.

Damage to the gasket or mating faces of the cylinder head and engine block will lead to leaks and therefore must be avoided. Before fitting a new gasket it is important to make sure there is no dirt between the layers of the gasket.

Glow Plugs

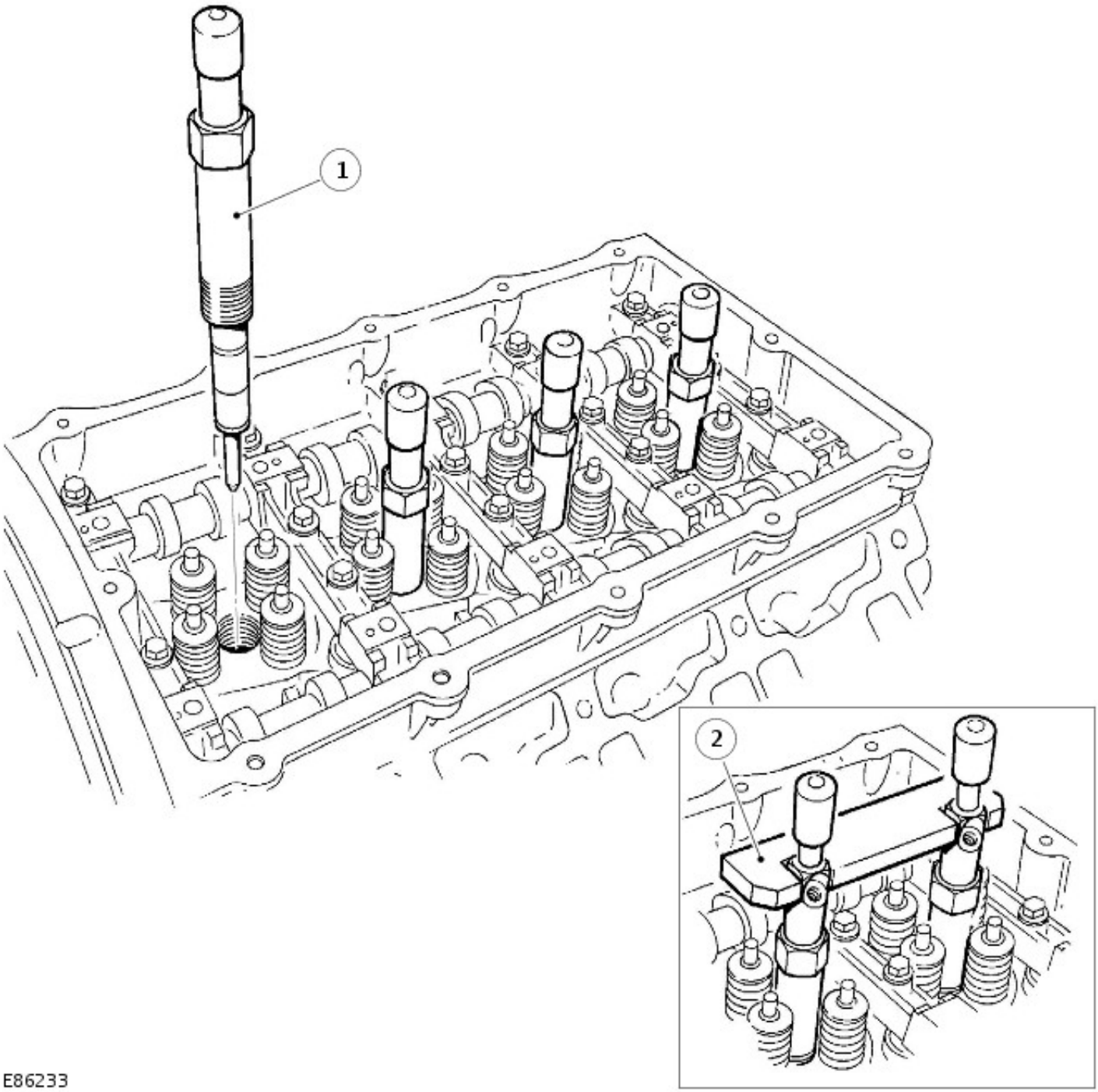


E85330

Item	Part Number	Description
1	-	Power supply wire
2	-	Glow plugs (4 off)

The glow plugs are arranged centrally on the inlet side of the cylinder head, between the two inlet ports of each cylinder.
For additional information, refer to: Glow Plug System (303-07 Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Injectors



Item	Part Number	Description
1	-	Injector
2	-	Injector alignment tool

The 4 electronic fuel injectors are centrally mounted; 1 above each cylinder and are fixed to the cylinder head by means of an injector nut.

The fuel injectors inject the quantity of fuel required for all the engine operating conditions into the combustion chambers. In order to achieve the optimal injection timing and precise injected fuel quantity, special fuel injectors with a hydraulic servo system and electrical actuator unit (solenoid valve) are used.

The injectors are actuated directly by the Engine Control Module (ECM). For additional information, refer to:

Fuel Charging and Controls (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation),
Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Cylinder Head Temperature (CHT) Sensor

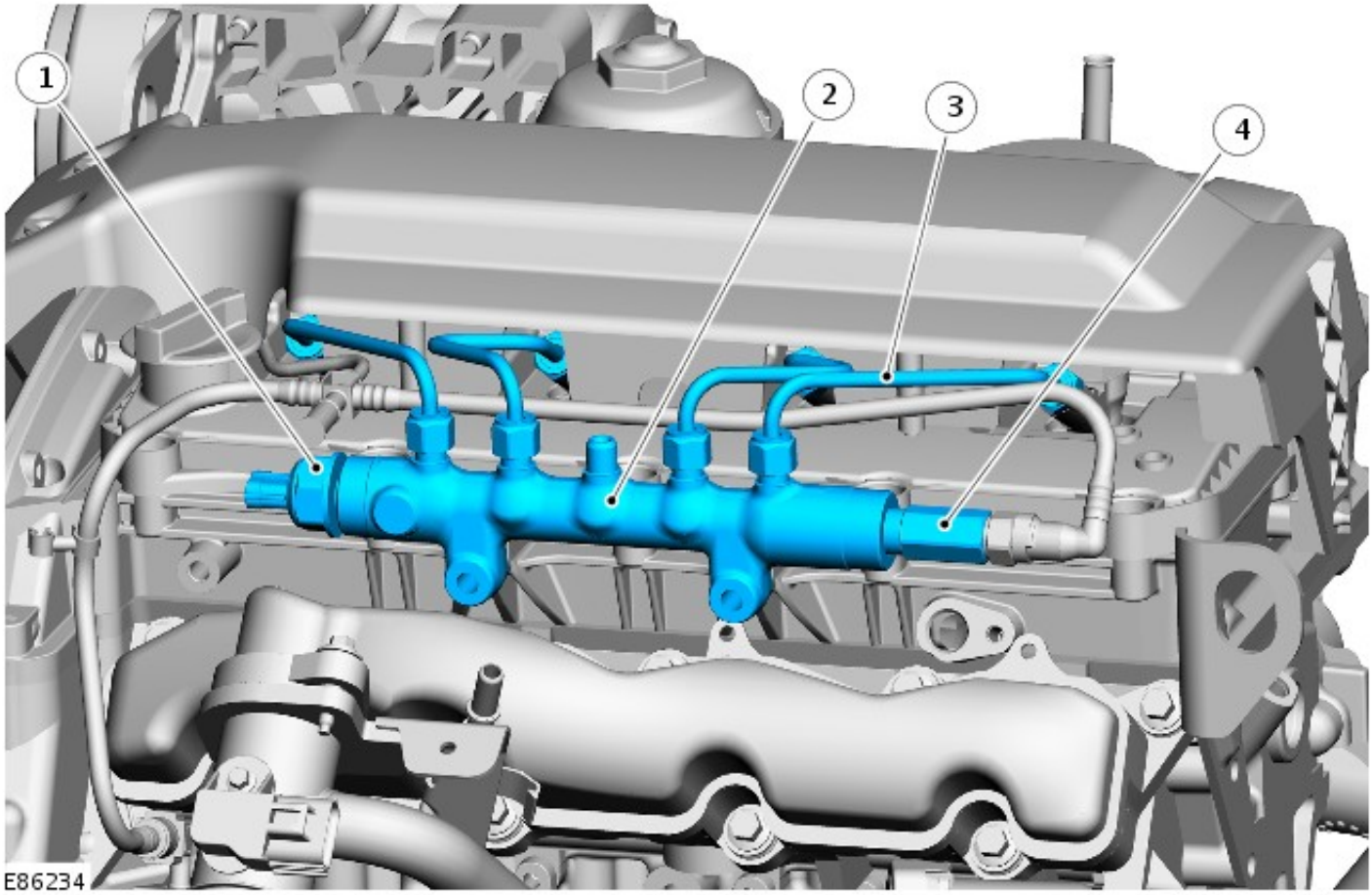
The CHT sensor is located at the centre rear of the cylinder head (transmission end). The sensor measures the temperature of the cylinder head and not the temperature of the coolant.

The CHT sensor affects the following functions:

- Quantity of fuel injected
- Start of fuel injection
- Idle speed
- Preheat operation
- EGR system

For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

High-Pressure Fuel Rail



Item	Part Number	Description
1	-	Fuel pressure sensor
2	-	High-pressure fuel rail
3	-	High-pressure fuel pipes (fuel rail to injectors)
4	-	Pressure limiting valve

The fuel rail, also known as the common rail, is manufactured from forged steel. It stores the fuel at high-pressure and prevents pressure fluctuations in the high-pressure system.

The fuel supplied by the high-pressure fuel pump passes through a high-pressure fuel line to the fuel rail. The fuel is then sent to the individual fuel injectors via the 4 injector tubes, which are all the same length.

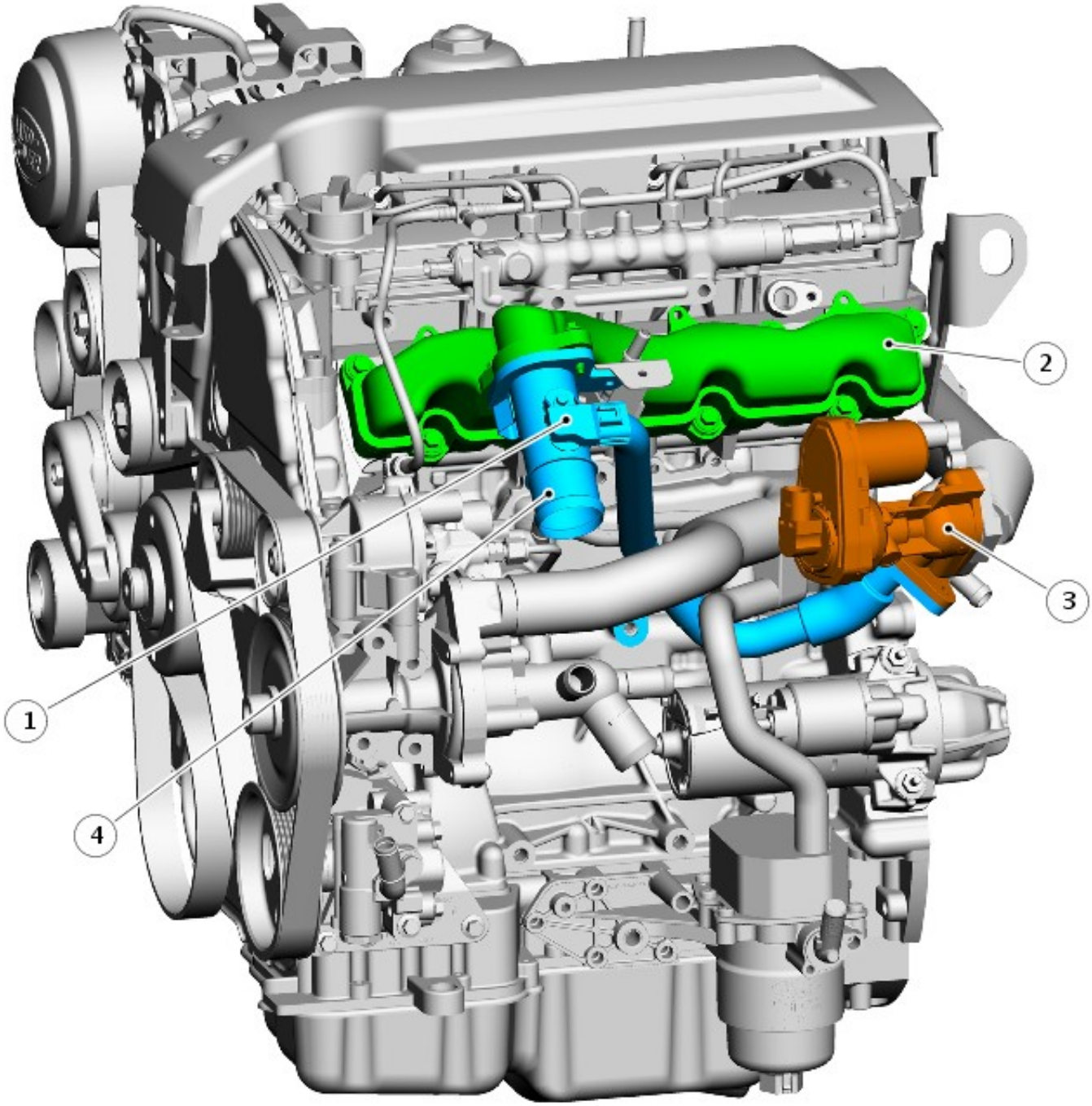
The pressure limiting valve opens at a fuel pressure of approximately 2000 bar. It serves as a safety device in the event of a malfunction within the high-pressure system, thus preventing damage due to excessive pressure.

• NOTE: The pressure limiting valve is a non-serviceable valve. It must be replaced if triggered, as the valve can no longer be guaranteed leak-free.

Triggering of the pressure limiting valve is detected by the ECM, whereupon a corresponding Diagnostic Trouble Code (DTC) is set and the Malfunction Indicator Lamp (MIL) is actuated. For additional information, refer to:

Fuel Charging and Controls (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation),
Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inlet Manifold

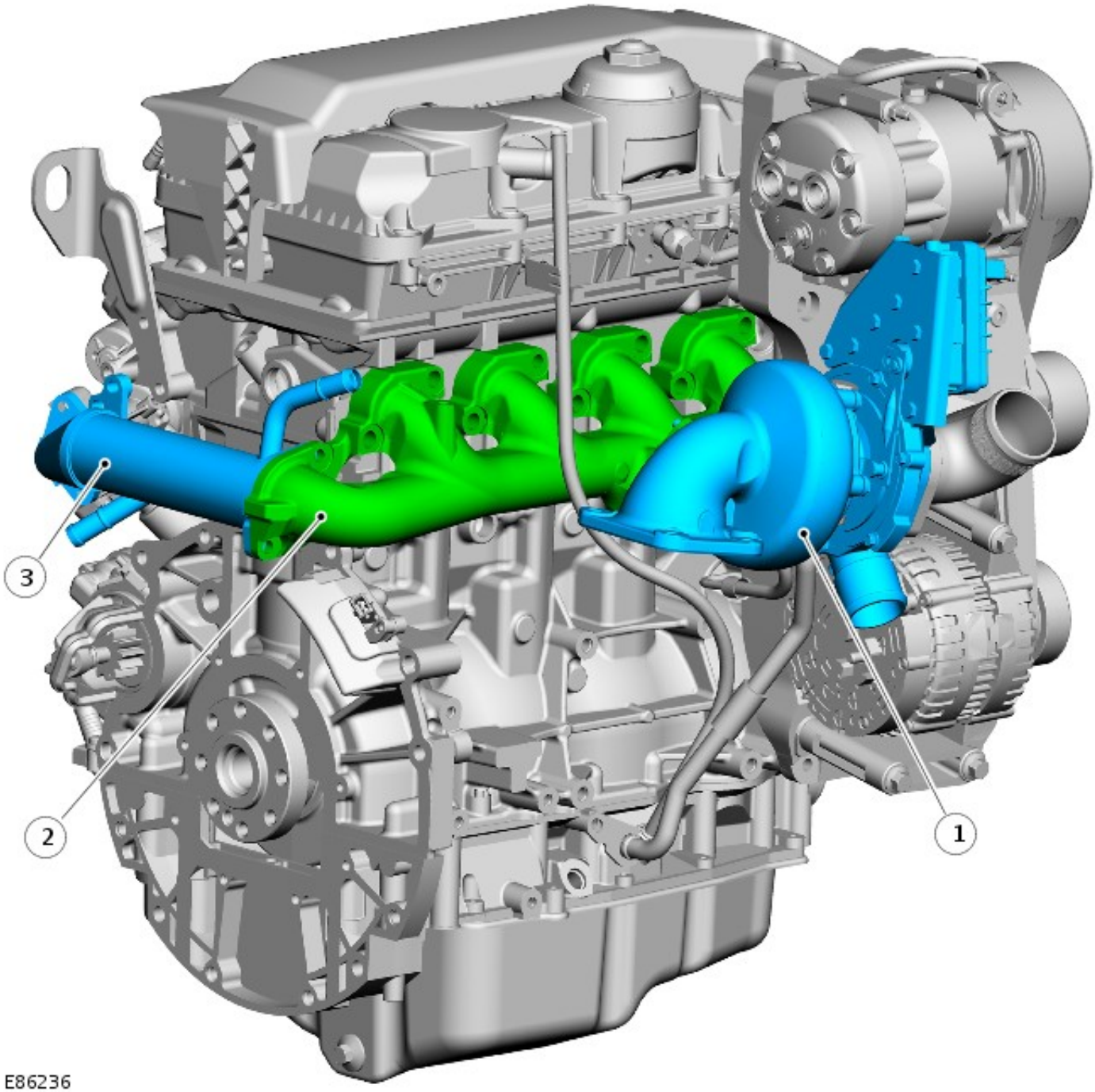


E86235

Item	Part Number	Description
1	-	Mass Air Flow/Intake Air Temperature (MAF/IAT) sensor
2	-	Inlet manifold
3	-	EGR valve
4	-	EGR outlet assembly

The plastic inlet manifold is mounted on the LH side of the cylinder head and includes a connection for the EGR outlet pipe. The EGR outlet pipe also houses the MAF/IAT sensor, which is used by the ECM to calculate the amount of air entering the engine.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Exhaust Manifold



Item	Part Number	Description
1	-	Turbocharger assembly
2	-	Exhaust manifold
3	-	EGR cooler

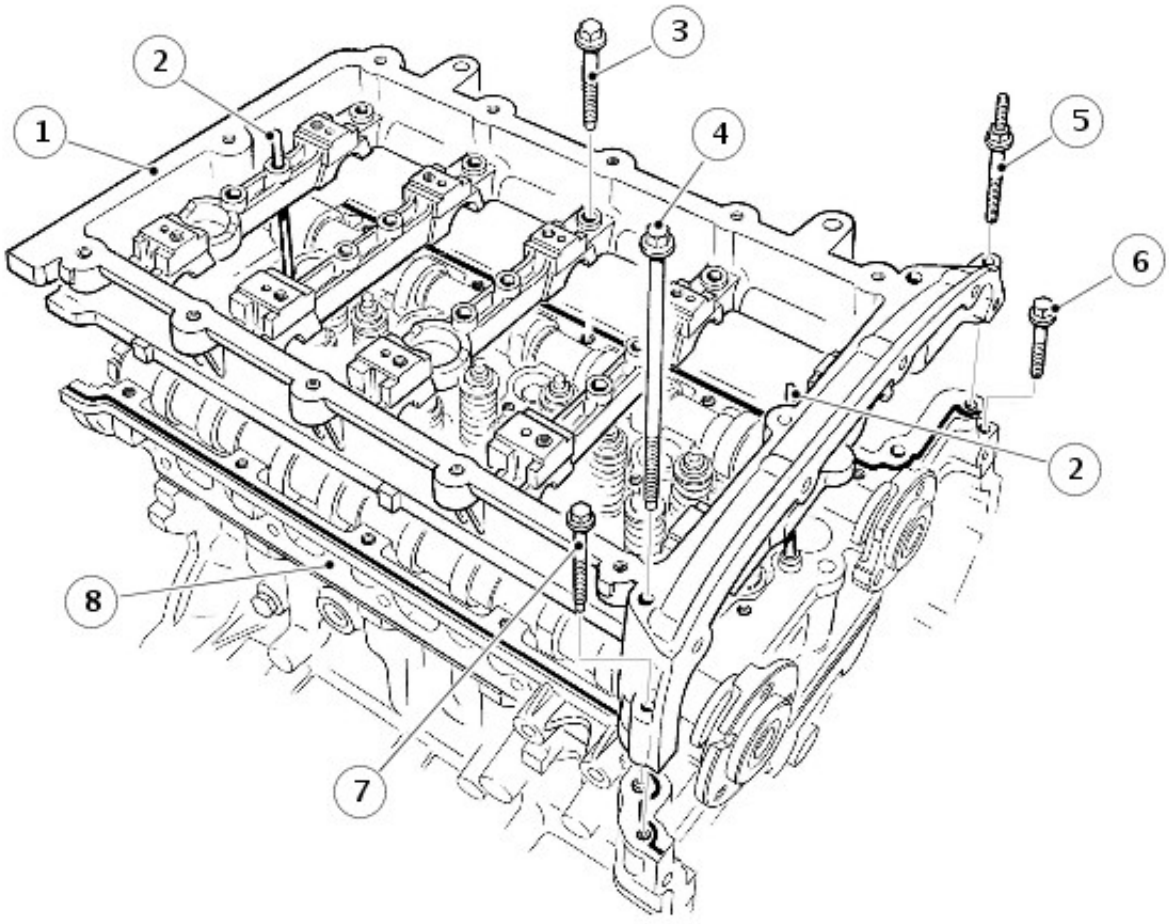
The cast iron exhaust manifold is secured to the cylinder head using 8 studs with nuts. Two metal gaskets seal the manifold to the cylinder head.

A flanged connection towards the front of the manifold provides for the attachment of the turbocharger. The turbocharger is attached to the flange with 3 bolts and sealed with a metal gasket.

A second flange, located on the rear of the manifold provides the connection point for the EGR cooler. The cooler flange is secured to the manifold with 2 bolts. There is no gasket between the EGR cooler and the exhaust manifold.

The EGR system directs exhaust gases into the inlet manifold to be used in the combustion process. The principal effect of this is to reduce combustion temperatures, which in turn reduces Nitrous Oxide (NOx) emissions.
For additional information, refer to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Camshaft Carrier

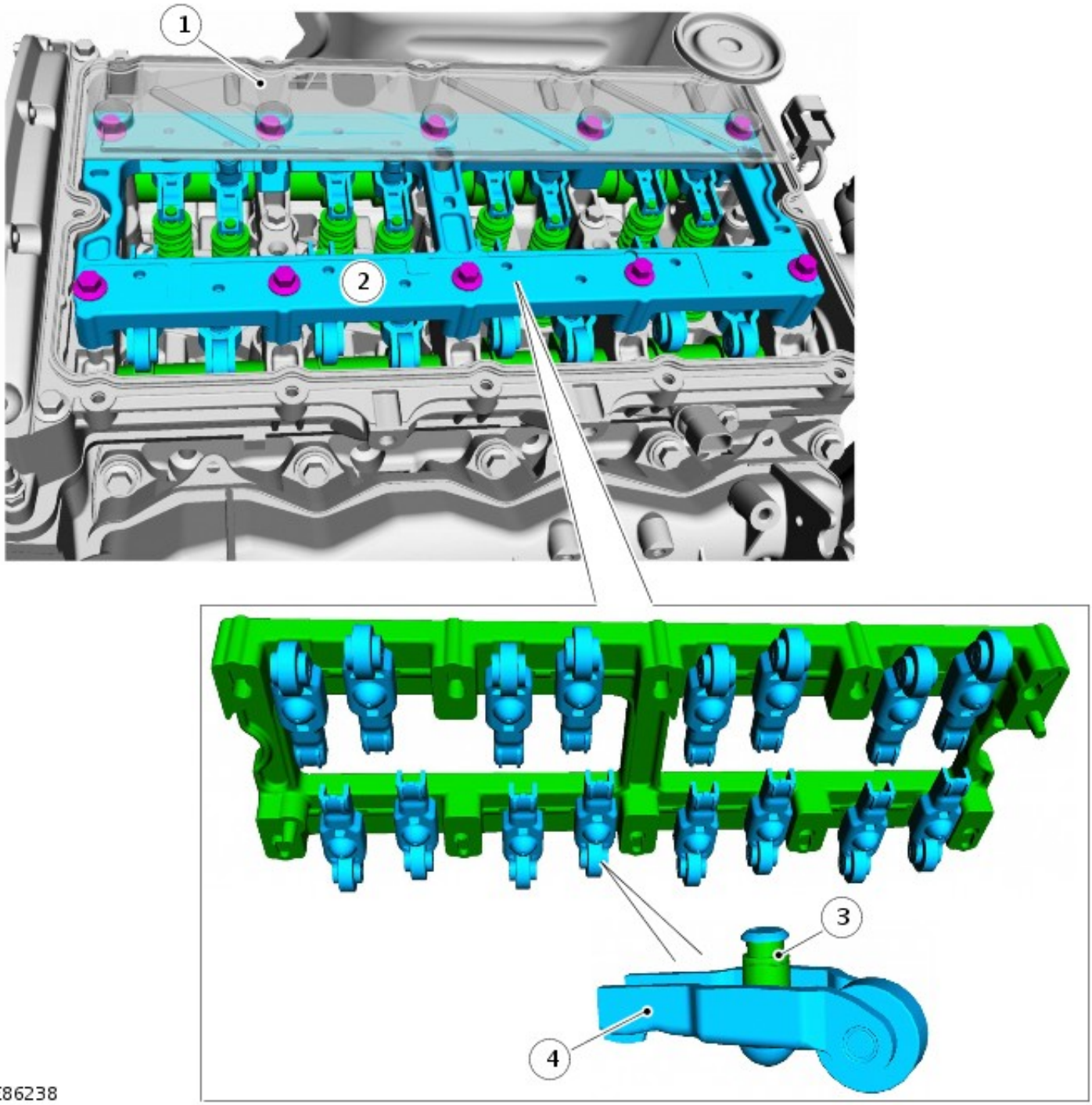


E86237

Item	Part Number	Description
1	-	Camshaft carrier
2	-	Alignment pin
3	-	Bolt (20 off)
4	-	Bolt (2 off)
5	-	Stud
6	-	Bolt
7	-	Bolt
8	-	Cylinder head

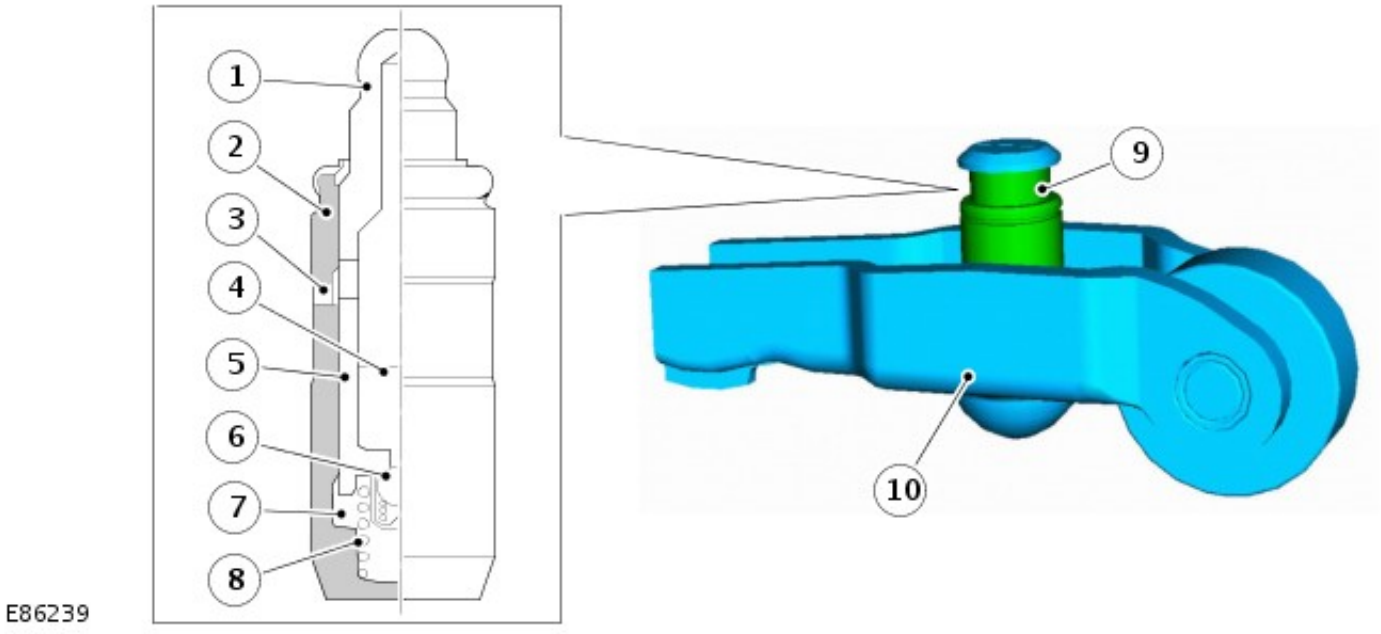
The aluminum camshaft carrier is located on top of the cylinder head and is retained by 24 bolts and a stud. Two alignment pins are used to accurately locate the carrier to the cylinder head.

Hydraulic Lash Adjusters



Item	Part Number	Description
1	-	Oil baffle plate
2	-	Aluminum support
3	-	Hydraulic lash adjuster (16 off)
4	-	Rocker arms (16 off)

The valves are operated through roller-type rocker arms and hydraulic lash adjusters, actuated by the camshaft lobes. The hydraulic lash adjusters are integrated in the rocker arms and the whole assembly is contained within the camshaft carrier. When the camshaft lobe presses down on the top of a finger rocker, roller mechanism, the respective valve is forced down, opening the effected inlet or exhaust port. The use of this type of actuation method helps reduce friction in the valve timing mechanism.

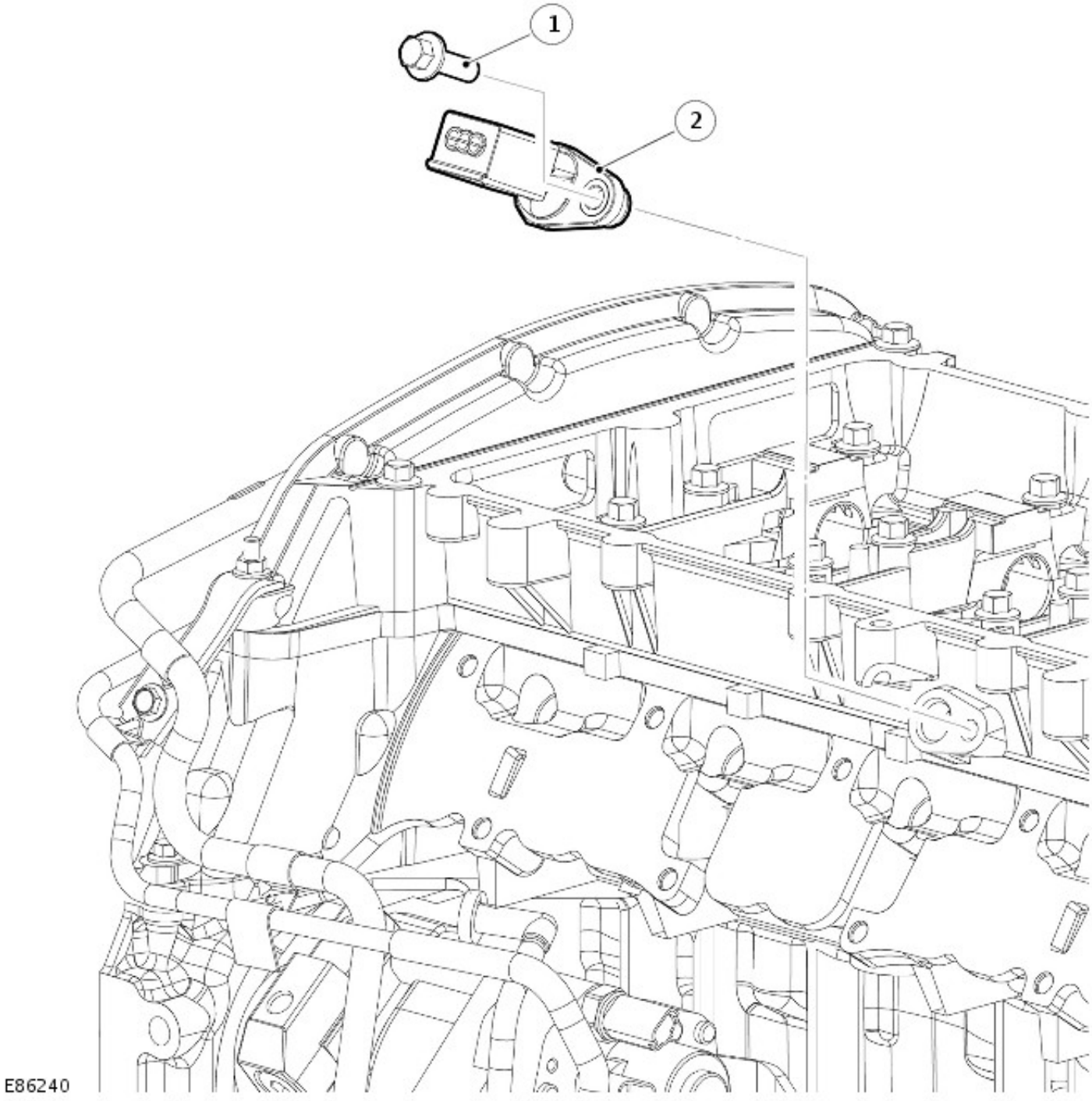


Item	Part Number	Description
1	-	Plunger cap
2	-	Hydraulic lash adjuster body
3	-	Oil hole
4	-	Reservoir chamber
5	-	Plunger
6	-	Check ball
7	-	High-pressure chamber
8	-	Plunger spring
9	-	Hydraulic lash adjuster
10	-	Rocker arms

The body of the hydraulic lash adjuster contains a plunger and 2 chambers for oil feed and pressurised oil. The pressurised oil is supplied to the adjusters via the main oil galleries in the cylinder head and through a hole in the side of the adjuster body. The oil passes into a feed chamber in the adjuster and then through to a separate pressure chamber via a 1-way ball valve.

Oil flow from the pressure chamber is determined by the amount of clearance between the adjuster outer body and the centre plunger. Oil escapes up the side of the plunger every time the adjuster is operated, the downward pressure on the plunger forcing a corresponding amount of oil in the adjuster body to be displaced. When the downward pressure from the camshaft and finger rocker is removed (i.e. after the trailing flank of the camshaft lobe has passed), oil pressure forces the adjuster's plunger up again. This pressure is not sufficient to effect the valve operation, but eliminates the clearance between the finger rocker and top of the valve stem.

Camshaft Position (CMP) Sensor



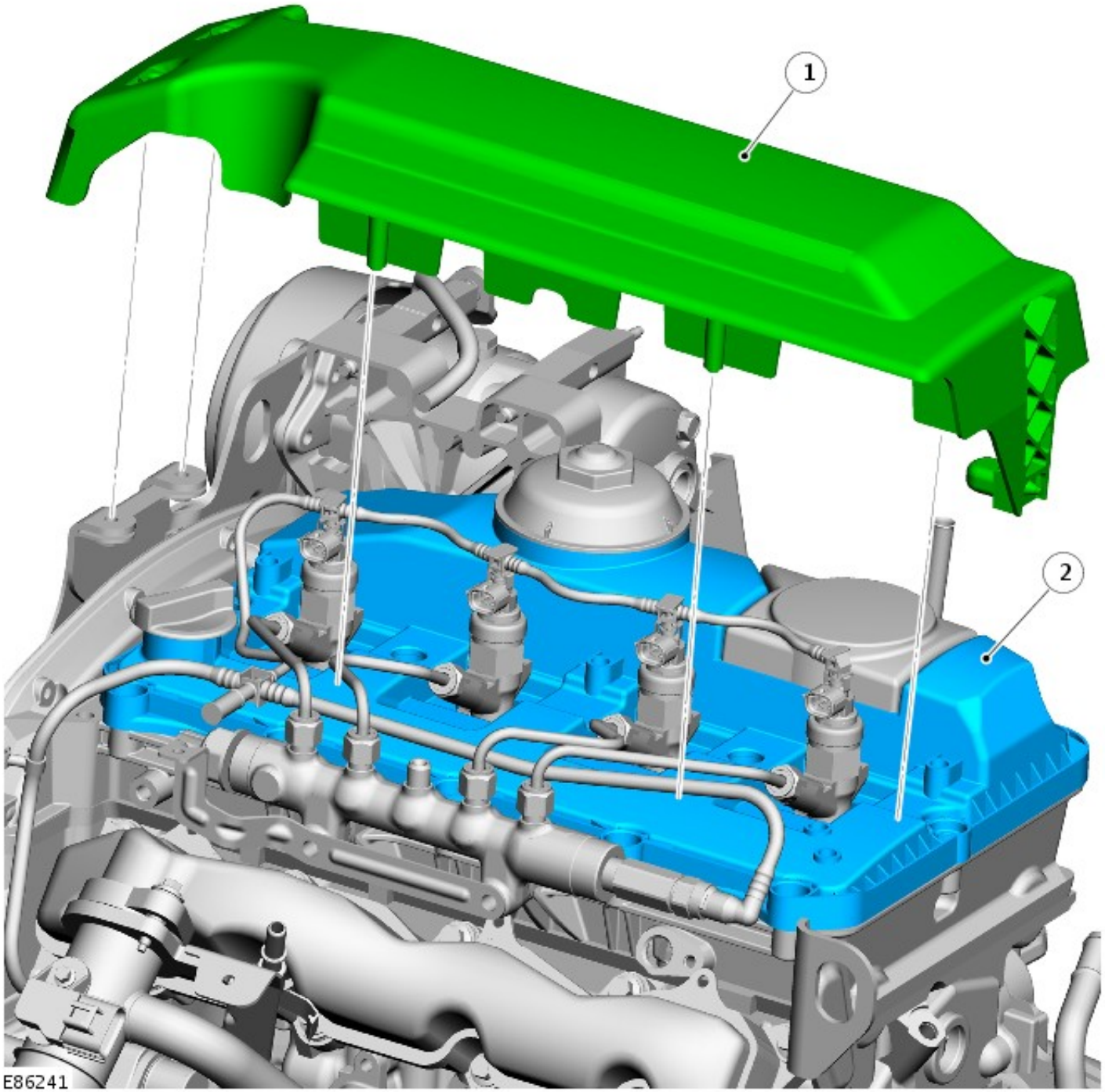
Item	Part Number	Description
1	-	Bolt
2	-	CMP sensor

The CMP sensor is located on the LH side of the cylinder head towards the rear. The sensor tip protrudes through the cylinder head to pick up on the reluctor on the inlet camshaft. The sensor is a Hall effect type sensor.

The ECM uses the CMP sensor signal to determine the engine position. Once this has been established, the ECM can then operate the correct injector to inject fuel into the cylinder when the piston is at injection Top Dead Centre (TDC).

The CMP sensor is used by the ECM at engine start-up to synchronize the ECM with the CKP sensor signal. The ECM does this by using the CMP sensor signal to identify number 1 cylinder to ensure the correct injector timing. Once the ECM has established the injector timing, the CMP sensor signal is no longer used.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Camshaft Cover and Engine Cover



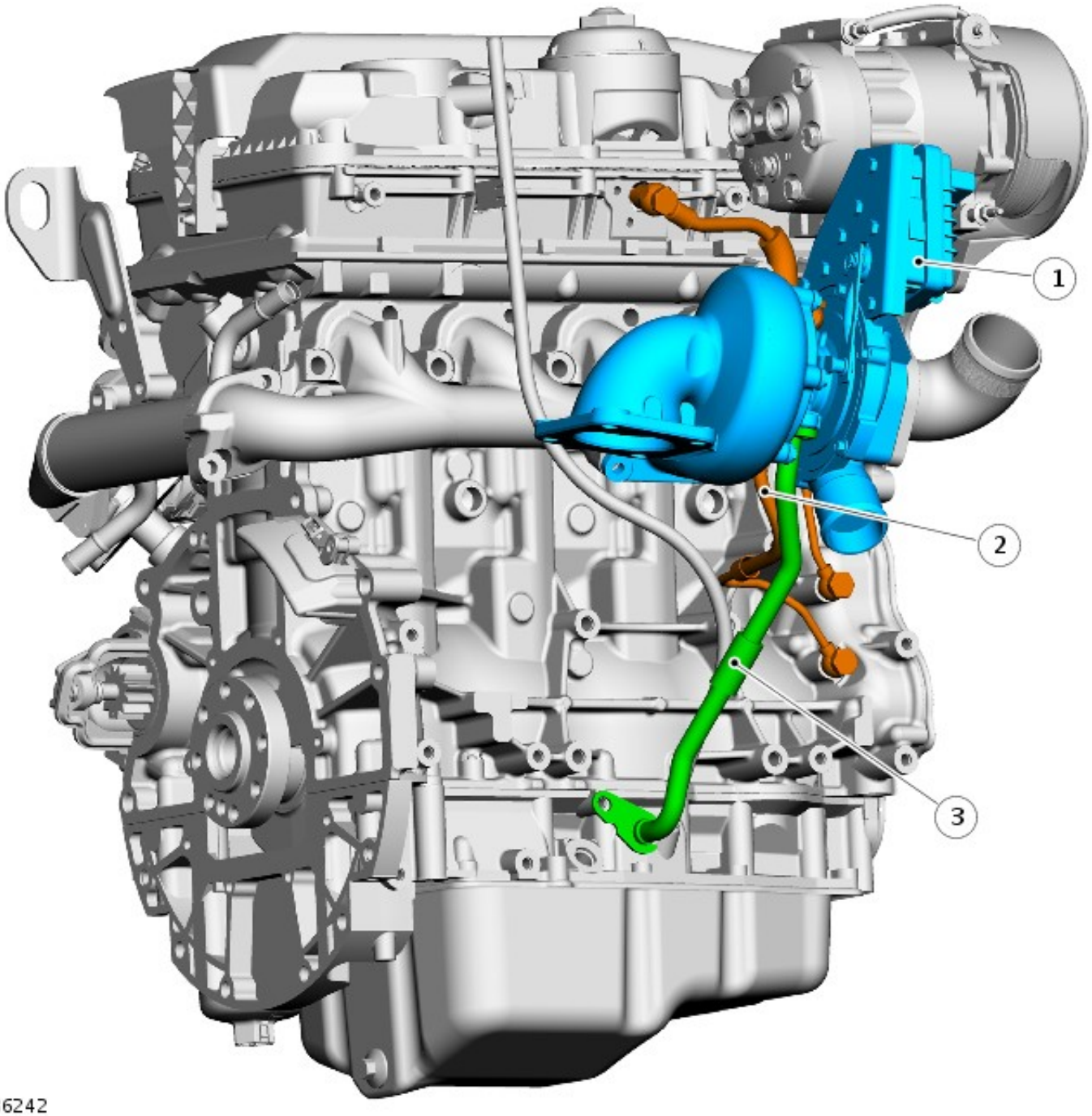
Item	Part Number	Description
1	-	Engine cover
2	-	Camshaft cover

LUBRICATION SYSTEM

The main lubrication system components are:

- Turbocharger oil return
- Oil pick-up
- Oil pump
- Oil filter and cooler assembly
- Oil pressure switch
- Oil level gage

Turbocharger Oil Return



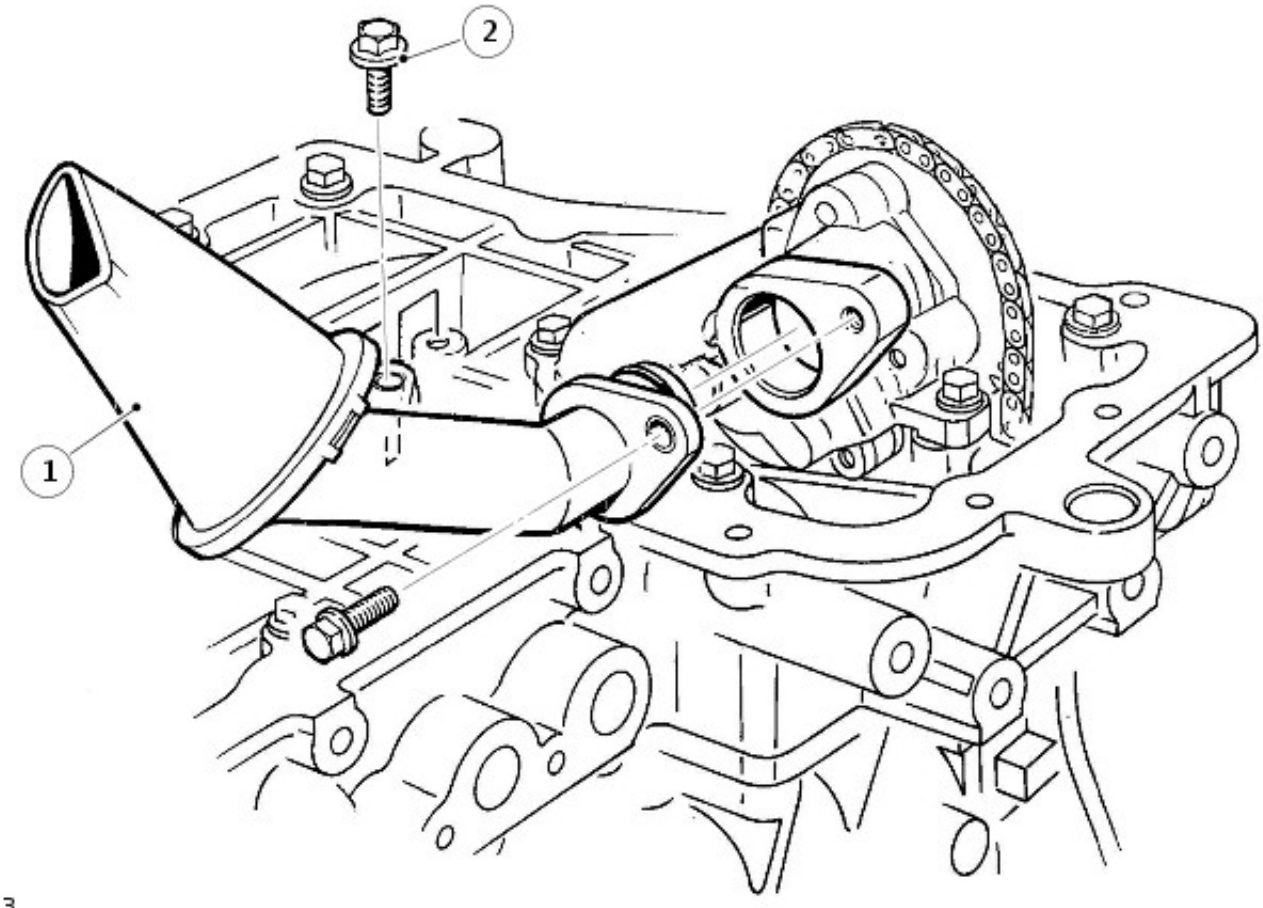
E86242

Item	Part Number	Description
1	-	Turbocharger assembly
2	-	Turbocharger oil feed pipe
3	-	Turbocharger oil return pipe

A tapping at the front RH side of the cylinder block, behind the generator mounting bracket, connects a pipe to the turbocharger by means of a banjo connection. Oil is supplied, under pressure via this tapping, from the oil pump to provide lubrication for the turbocharger bearings.

A port is included at the LH side of the ladder frame, below the turbocharger, to connect the turbocharger oil return pipe to the sump.

Oil Pick-up

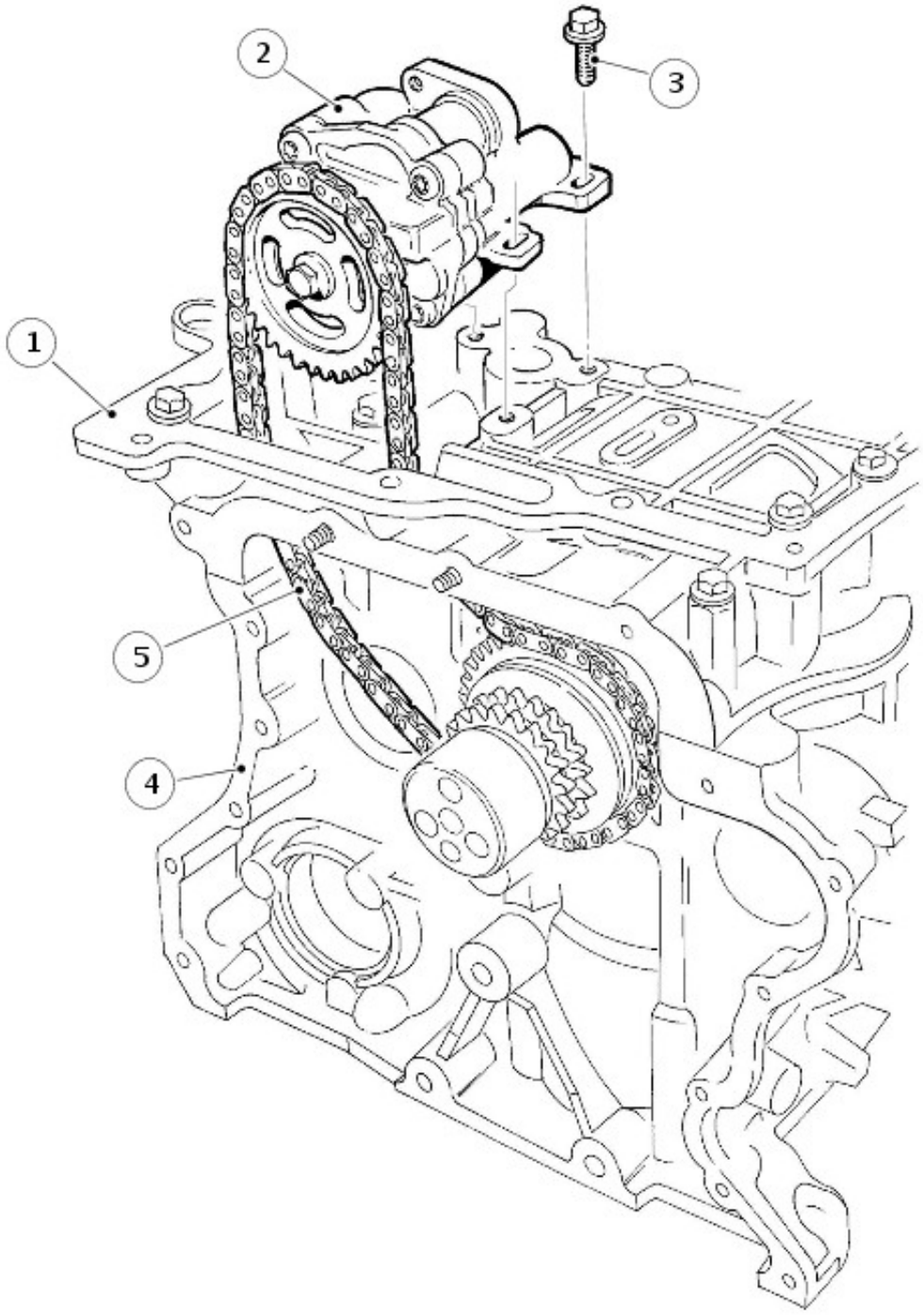


E86243

Item	Part Number	Description
1	-	Oil pick-up pipe
2	-	Bolt (2 off)

The fabricated steel oil pick-up is immersed in the oil reservoir to provide a supply to the oil pump during all normal vehicle attitudes. A mesh screen in the inlet prevents debris from entering the oil system.

Oil Pump



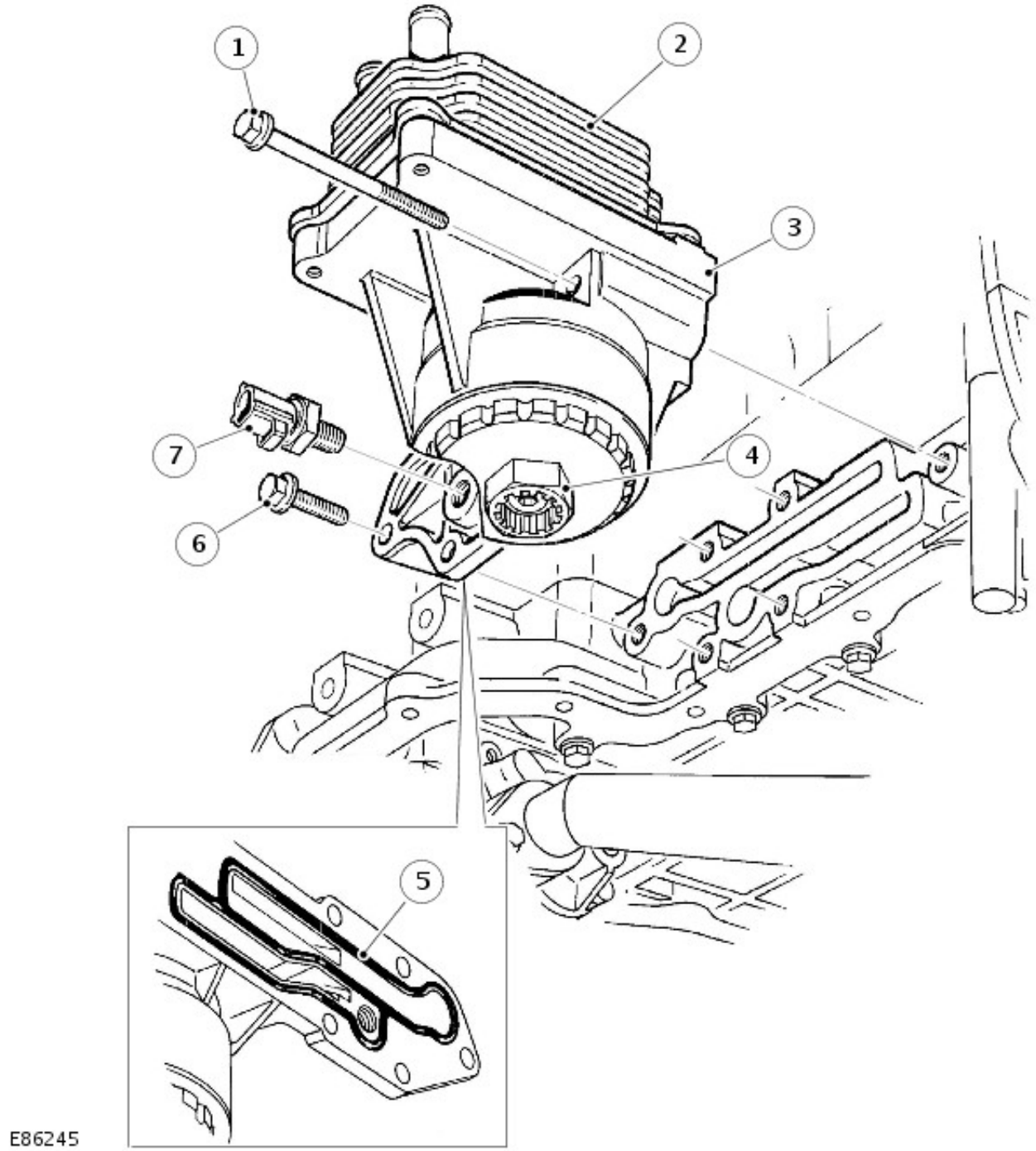
E86244

Item	Part Number	Description
1	-	Ladder frame
2	-	Bolt (4 off)
3	-	Oil pump
4	-	Cylinder block
5	-	Oil pump drive chain

The oil pump is located on the LH front underside of the ladder frame and is secured by 4 bolts. The unit is driven by a drive chain, via the crankshaft sprocket, and receives its oil feed from the main gallery via drillings in the cylinder block.

The chain is tensioned and guided by means of a hydraulic chain tensioner.

Oil Filter and Cooler Assembly



Item	Part Number	Description
1	-	Bolt (2 off)
2	-	Engine oil cooler
3	-	Oil filter housing
4	-	Oil filter drain plug
5	-	Oil filter and cooler assembly seal
6	-	Bolt (4 off)
7	-	Oil pressure switch

The engine is lubricated by a forced feed oil circulation system with a oil filter and oil cooler assembly.

The oil filter and oil cooler assembly is attached to the LH side of the ladder frame and consists a full-flow, disposable canister-type filter, oil cooler and oil pressure switch. The mounting plate aligns with the oil gallery in the ladder frame and is sealed by an 'O' ring.

The engine cooling system cools the oil in the oil cooler and is regulated by means of a separate thermostat, which prevents the flow of coolant through the oil cooler when the engine is cold, ensuring the engine oil warms up quickly. The thermostat opens at 75±2°C (167±35°F).

Oil is delivered to and from the oil cooler through galleries in the cylinder block. Hoses from the engine cooling system are connected to 2 pipes on the oil cooler for the supply and return of coolant.

Oil is drawn, via a strainer and pick-up pipe in the sump into oil pump, which has an integral pressure relief valve. The strainer in the pick-up pipe prevents any ingress of foreign particles from passing through to the inlet side of the oil pump and damaging the oil pump and restricting oil drillings. The oil pressure relief valve in the oil pump opens if the oil pressure becomes excessive and diverts oil back around the pump.

The lubrication system is designed so that a higher proportion of oil flow is directed to the cylinder block main oil gallery while a lower proportion of oil flow, (controlled by a restrictor in the oil filter housing), is directed to the engine oil cooler. The remainder of the oil flow from the outlet side of the oil filter is combined with the return flow from the oil cooler before being passed into the cylinder block main oil gallery.

The main oil gallery has drillings that direct the oil to the cylinder head and the main bearings. Cross drillings in the crankshaft main bearings carry the oil to the connecting rod big-end bearings. Oil galleries in the cylinder head carry the oil to the camshafts and the hydraulic lash adjusters.

The oil pressure switch is located in the oil filter and oil cooler mounting plate to sense the oil pressure level before the oil flow enters the main gallery in the cylinder block. A warning lamp in the instrument cluster is illuminated if low oil pressure is detected.

Oil at reduced pressure is directed towards the cylinder head via a restrictor in the cylinder block/cylinder head locating dowel. Oil then passes through a drilling in the cylinder head to the camshaft carrier, where it is directed via separate galleries to the camshaft bearings and hydraulic tappet housings. Return oil from the cylinder head drains into the sump via the cylinder head bolt passages.

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine
Diagnosis and Testing

Overview

As diagnosis of the different areas of the engine is covered in other sections and by general procedures, this section is limited to an oil pressure test.

For specific areas of the engine, refer to the general procedures in this section and the relevant section of the manual.

Inspection and Verification

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

Visual Inspection Chart

Mechanical	Electrical
• Engine oil level • Coolant level • Transmission fluid level • Fuel level • Coolant leaks • Oil leaks • Fuel leaks • Visibly damaged or worn parts • Loose or missing nuts or bolts • Fuel contamination/grade/quality • Sensor fitment/condition • Viscous fan and solenoid • Routing of pipework etc. to avoid vibrations • Contact anywhere between the driveline and chassis	• Fuses • Wiring harness • Electrical connector(s) • Injectors • Glow plugs • 5 volt sensor supply • Sensor(s) • Viscous fan solenoid • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.

Oil Pressure Check

• NOTE: Prior to checking the engine oil pressure, a road test of 6 miles (10 kilometres), must be carried out. Do not attempt to attain engine normal operating temperature by allowing the engine to idle.

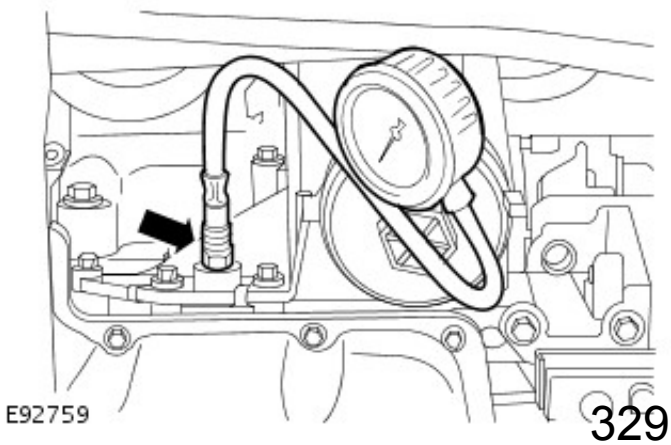
1. • WARNINGS:

   The spilling of hot engine oil is unavoidable during this procedure, care must be taken to prevent scalding. Failure to follow this instruction may result in personal injury.

   Wear protective gloves.

   1. Remove the oil pressure sensor.
   REFER to: Engine Oil Pressure (EOP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

2. **2.** Install the oil pressure gauge and the oil pressure gauge connector.



3. **3.** Check and top-up the engine oil, if required.
4. **4.** Start and run the engine.
5. **5.** Note the oil pressure readings with the engine running at idle and at 2,000 rpm.
   REFER to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).
6. **6.** Turn off the engine.
7. **7.** Remove the special tools.
8. **8.** Install the oil pressure sensor.
   REFER to: Engine Oil Pressure (EOP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
9. **9.** Check and top-up the engine oil, if required.

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Oil Draining and Filling

General Procedures

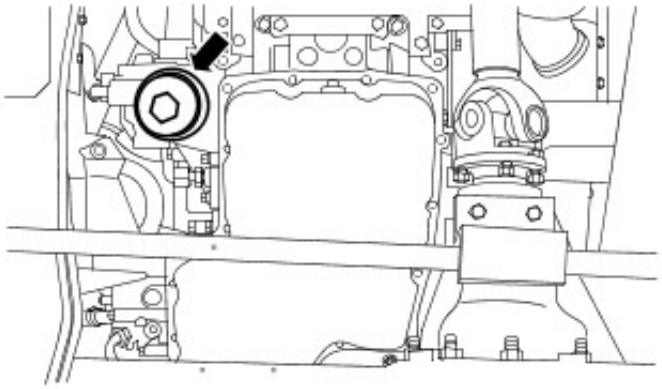
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

2. Loosen the oil filter cover 3 turns and allow the engine oil to drain.

3. NOTE: Position cloth to collect fluid spillage.

Remove the oil filter cover and oil filter element.



E90315

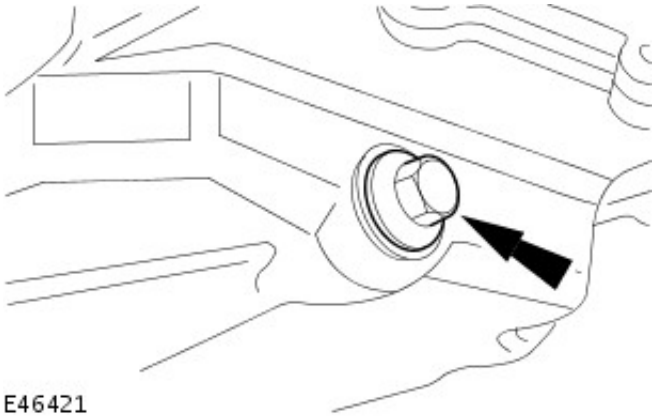
4. Remove and discard the oil filter element.

- Remove and discard the oil filter cover O-ring seal.

E90316

5. Drain the engine oil.

- Position a container to collect the engine oil.
- Remove and discard the drain plug.
- Allow the engine oil to drain.



E46421

6. Install a new drain plug.

- Clean the component mating faces.
- Tighten the drain plug to 23 Nm (17 lb.ft).
- Remove the container.

7. Install a new oil filter cover O-ring seal.

- Clean the components.
- Lubricate the O-ring seal with clean engine oil.

8. Install a new oil filter element to the oil filter cover.

9. Install the oil filter cover and oil filter element.

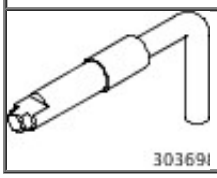
- Tighten the oil filter cover to 35 Nm (26 lb.ft).

10. Fill the engine with the recommended oil to the correct level.

11. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

12. Check and top-up the engine oil.

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Camshafts
In-vehicle Repair

Special Tool(s)	
	Timing tool, crankshaft 303-698

Removal

All vehicles

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

2. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the valve cover.
   For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

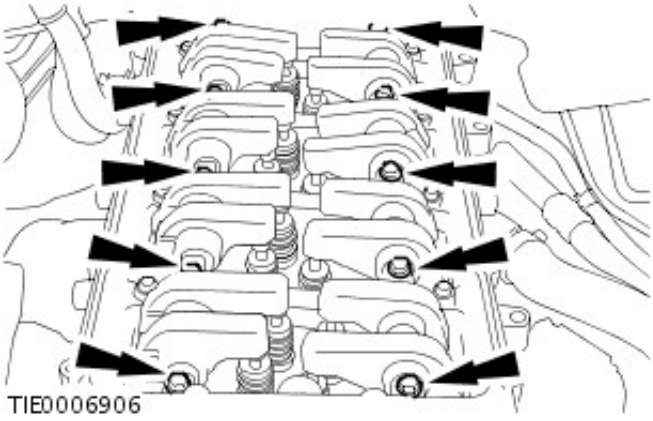
4. Remove the timing cover.
   For additional information, refer to: Timing Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

5. Remove the generator.
   For additional information, refer to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

6. Remove the crankshaft position (CKP) sensor.
   For additional information, refer to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

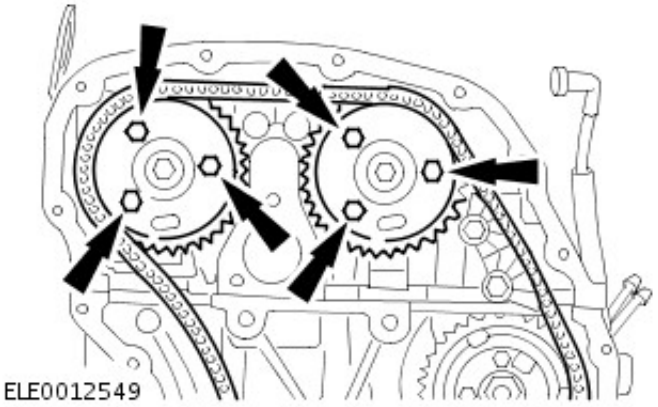
7. Remove the 2 rocker shafts.

   - Remove and discard the 10 bolts.


TIE0006906

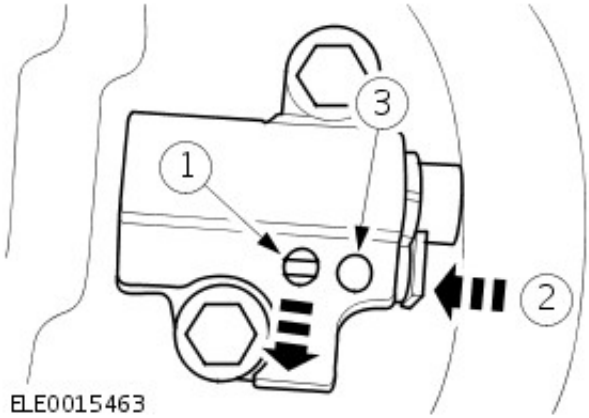
8. Loosen the 6 camshaft sprocket bolts.

8. Loosen the 3 camshaft sprocket bolts.



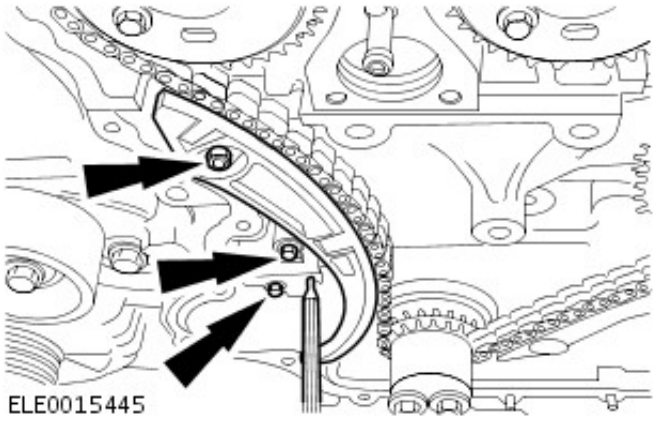
9. Detension and lock the timing chain tensioner.

1. Retract the pawl.
2. Push the lock in.
3. Insert a suitable pin.



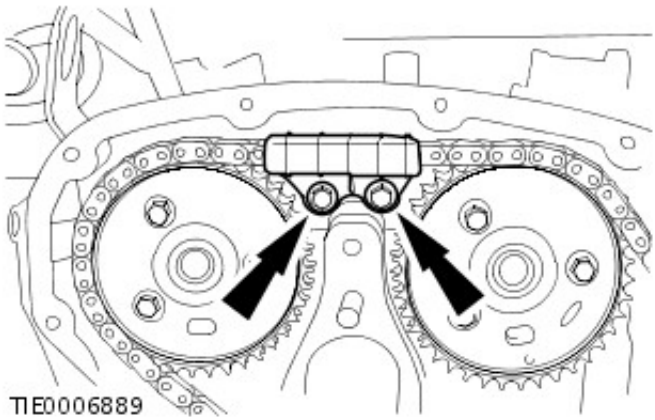
10. Remove the timing chain tensioner and the RH timing chain guide.

- Remove the 2 bolts.
- Remove the nut.

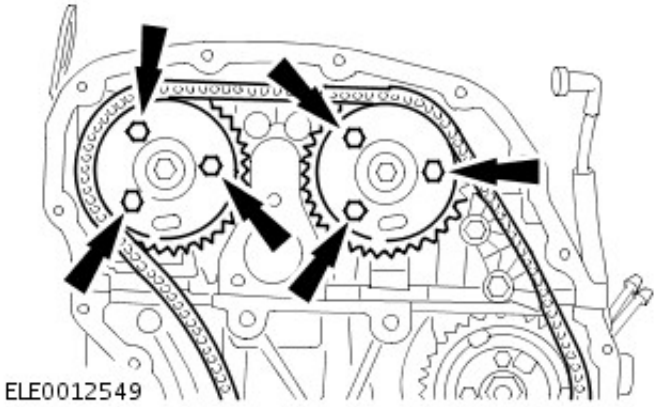


11. Remove the upper timing chain guide.

- Remove the 2 bolts.



12. Remove the camshaft sprockets and the timing chain.



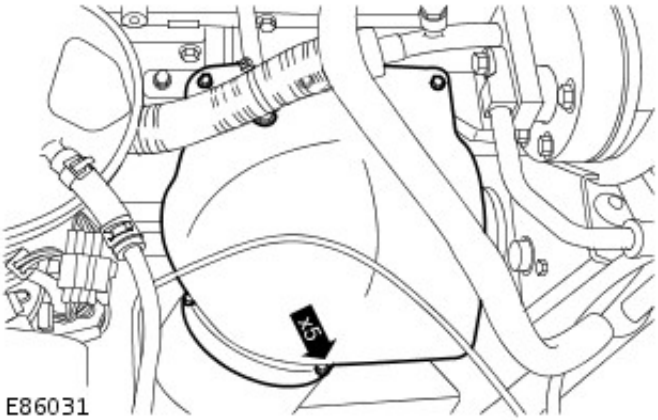
- Remove the 6 bolts.

Vehicles with air conditioning

13. Remove the air conditioning compressor.
For additional information, refer to: Air Conditioning (A/C) Compressor (412-03 Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

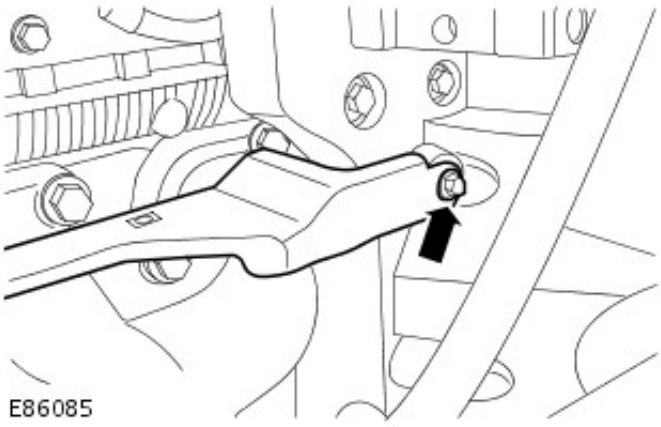
All vehicles

14. Remove the turbocharger heatshield.



- Remove the 5 bolts.

15. Release the turbocharger heat shield bracket.

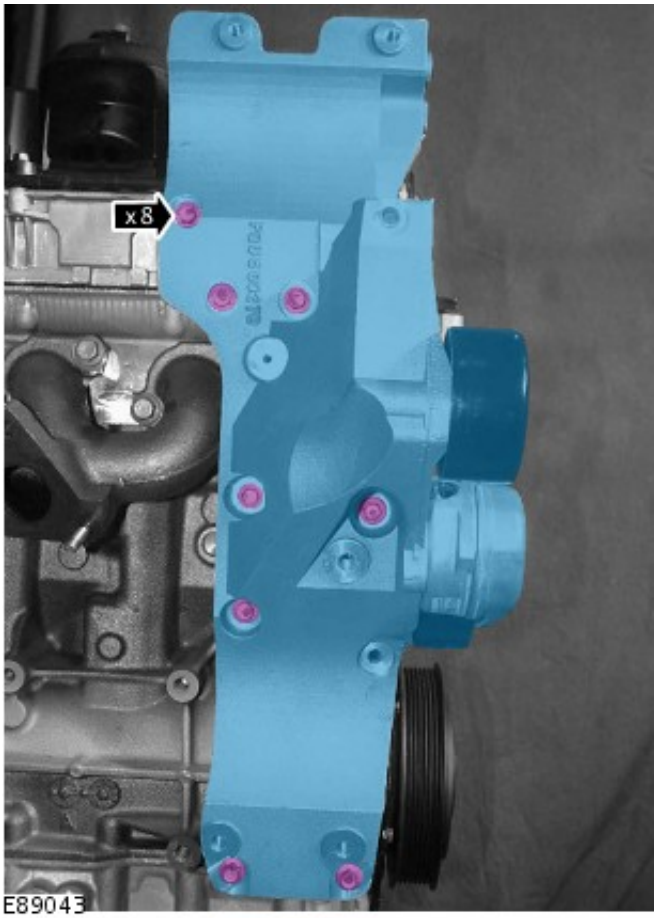


- Remove the bolt.

16. Remove the turbocharger heat shield bracket.

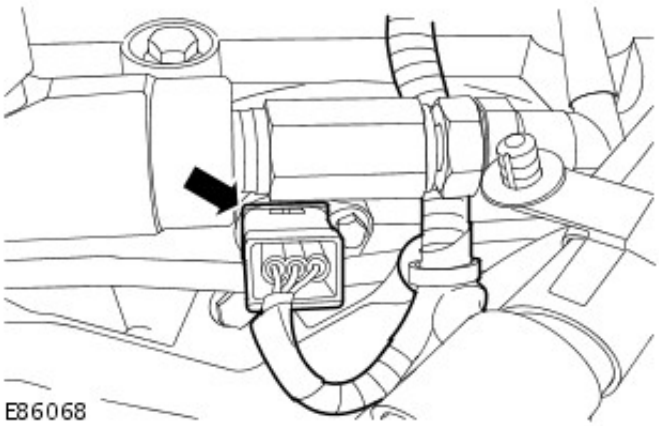
- Remove the bolt.

17. Remove the generator mounting bracket.

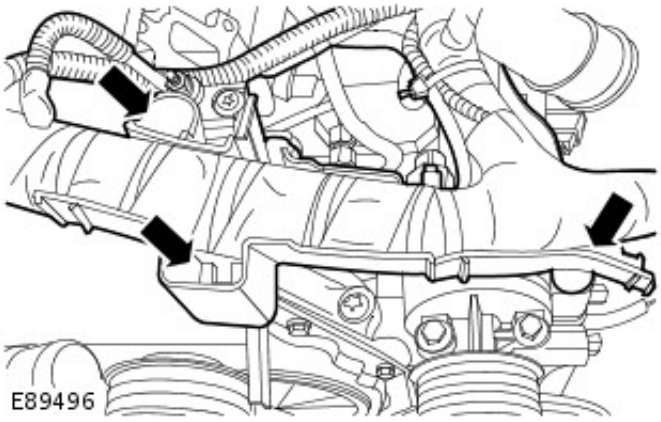


- Remove the 8 bolts.

18. Disconnect the camshaft position (CMP) sensor.

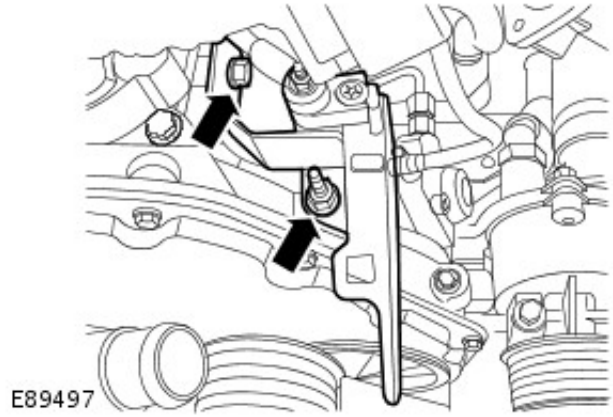


19. Release the engine wiring harness.



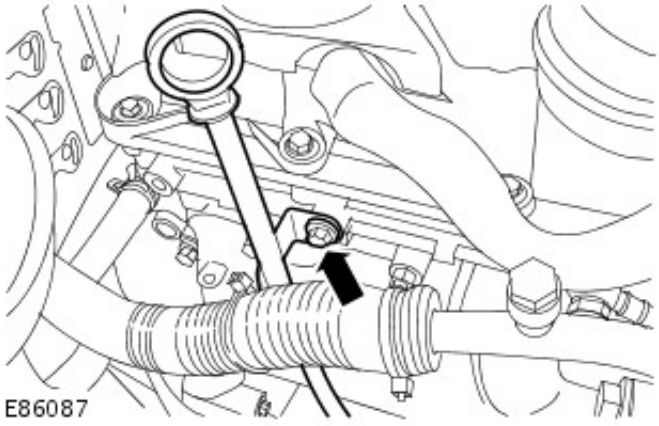
- Release the 3 clips.

20. Release the engine wiring harness support bracket.

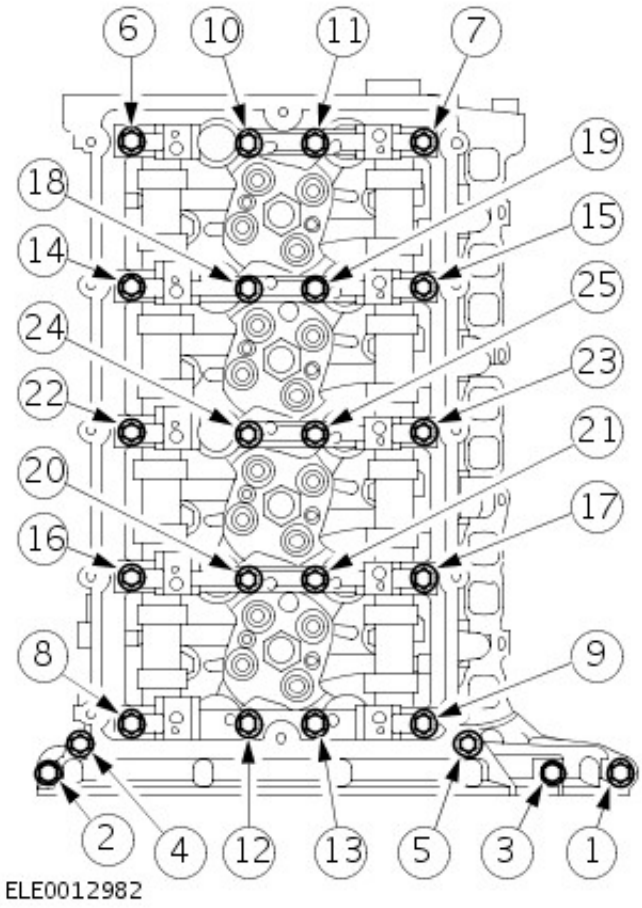


- Remove the bolt.
- Remove the nut.

21. Release the oil level indicator tube.



- Remove the bolt.



22. CAUTION: Remove the bolts in the sequence shown. Failure to follow this instruction may result in damage to the vehicle.

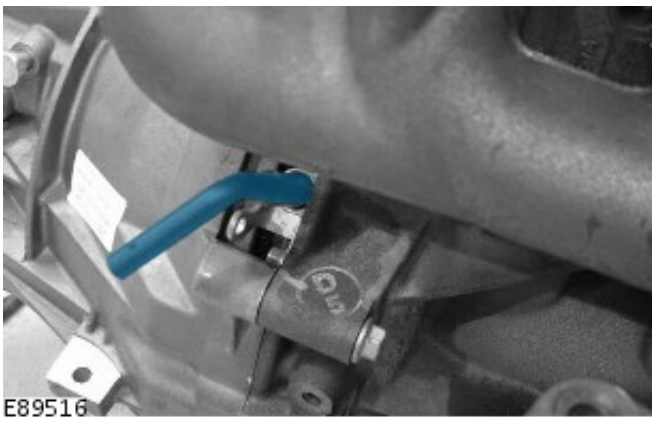
Remove the camshaft carrier.

- Remove the 25 bolts.

23. Remove both of the camshafts.

Installation

All vehicles



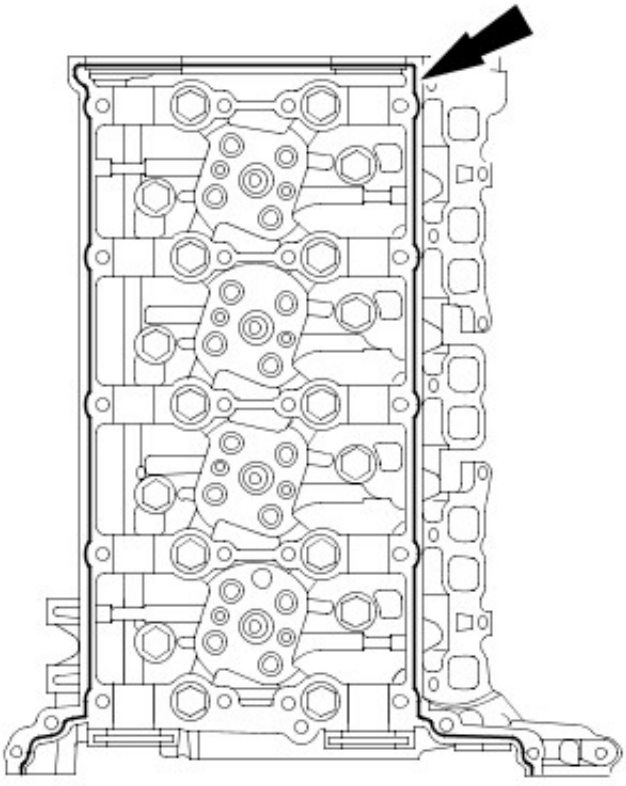
1. CAUTION: Do not turn the crankshaft when the special tool is fully located into the flywheel. Failure to follow this instruction may result in damage to the vehicle.

Rotate the crankshaft to 50 degrees before top dead center (BTDC).

- Install the special tool through the CKP sensor hole.

2. NOTE: Clean the component mating face.

Apply a 2.5 mm (0.1 inches) diameter bead of the specified sealant to the cylinder head.

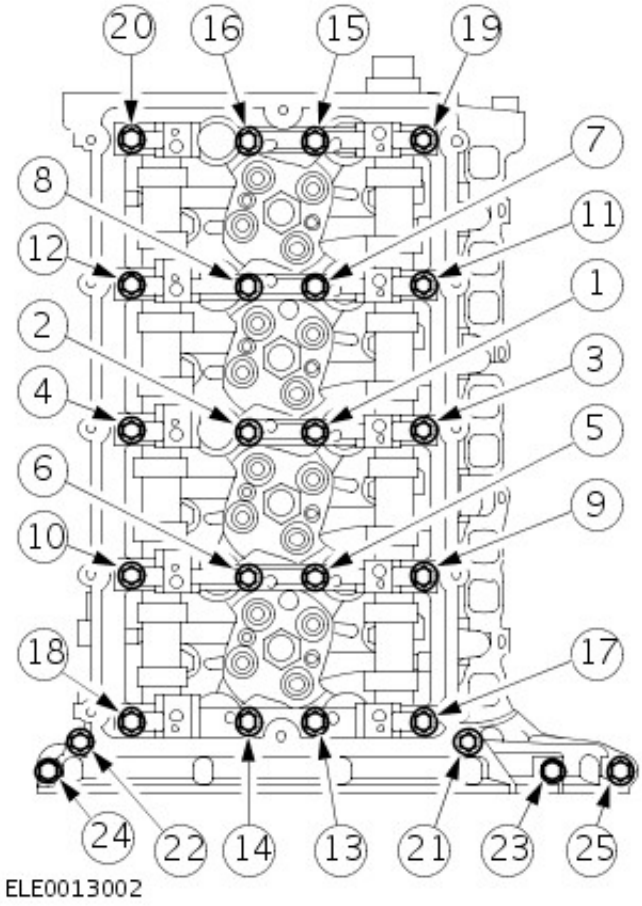


ELE0013422

3. NOTE: Clean the component mating faces.

Install both of the camshafts.

- Lubricate the camshaft journals and the camshaft lobes with clean engine oil.



4. CAUTION: Tighten the bolts in the sequence shown, failure to follow this instruction may result in damage to the vehicle.

• NOTE: Clean the component mating face.

Install the camshaft carrier.

- Stage 1: Tighten the bolts 1 through 22 to 23 Nm (16 lb.ft).
- Stage 2: Tighten the bolts 23 through 25 to 10 Nm (7 lb.ft).

5. Secure the oil level indicator tube.

- Tighten bolt to 10 Nm (7 lb.ft).

6. Secure the engine wiring harness support bracket.

- Tighten nut to 10 Nm (7 lb.ft).
- Tighten bolt to 10 Nm (7 lb.ft).

7. Secure the engine wiring harness.

- Secure the clips.

8. Install the generator mounting bracket.

- Tighten the bolts to 25 Nm (18 lb.ft).

9. Install the turbocharger heat shield bracket.

- Tighten the M6 bolt to 10 Nm (7 lb.ft).
- Tighten the M8 bolt to 20 Nm (15 lb.ft).

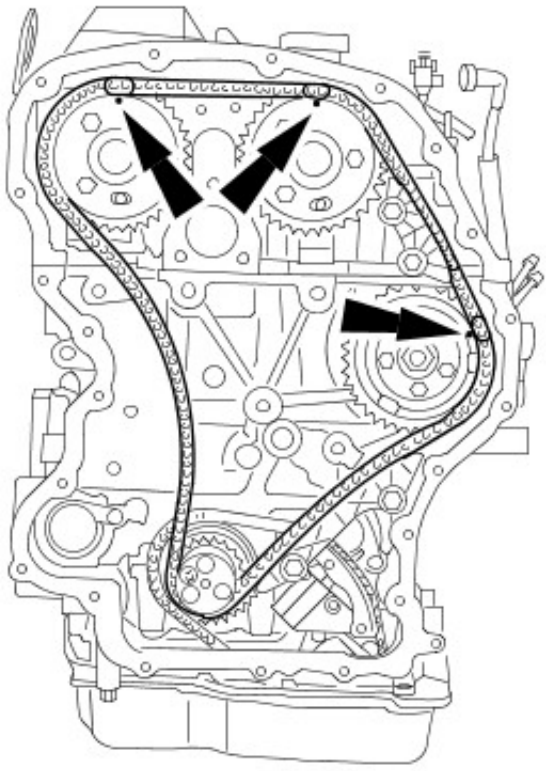
10. Install the turbocharger heatshield.

- Tighten to 7 Nm (5 lb.ft).

Vehicles with air conditioning

11. Install the A/C compressor.
For additional information, refer to: Air Conditioning (A/C) Compressor (412-03 Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

All vehicles



E46627

12. CAUTION: Make sure the colored links align to the timing marks. Failure to follow this instruction may result in damage to the vehicle.

Install both of the camshaft sprockets and the timing chain.

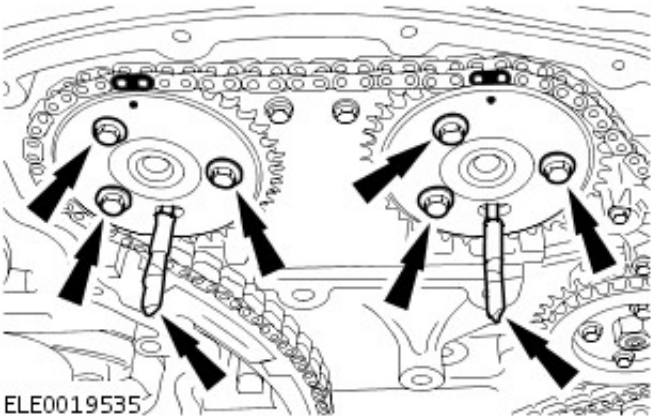
13. CAUTION: Make sure the timing chain tensioner is fully retracted before installation. Failure to follow this instruction may result in damage to the vehicle.

Install the timing chain tensioner and the timing chain guides.

- Tighten the bolts to 15 Nm (11 lb.ft).
- Tighten the nut to 15 Nm (11 lb.ft).

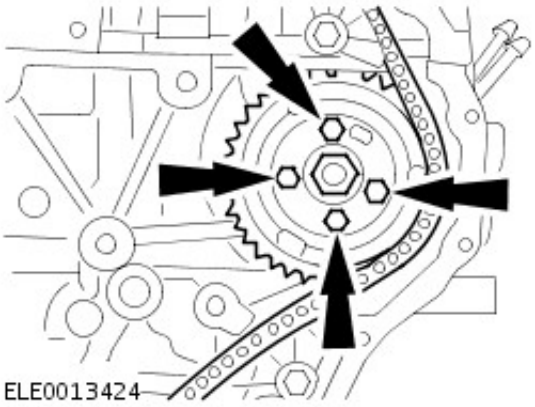
14. Using a suitable 6 mm bar, lock the camshaft sprockets.

- Loosely install the camshaft sprocket bolts.



ELE0019535

15. Loosen the 4 bolts on the fuel injection pump sprocket.



16. NOTE: Make sure the timing chain tensioner is completely released.

Unlock the timing chain tensioner.

- Remove the pin.

17. Secure the camshaft sprockets and the fuel injection pump sprocket.

- Tighten the camshaft sprocket bolts to 35 Nm (24 lb.ft).
- Tighten the fuel injection sprocket bolts to 33 Nm (26 lb.ft).

18. Remove the special tool.

19. Remove the 6 mm bars.

20. CAUTIONS:

Make sure that new bolts are installed.

Make sure that the oil supply holes in the rocker shafts point downwards. Failure to follow this instruction may result in damage to the vehicle.

• NOTE: Tighten the bolts in the stages shown.

Install the rocker shafts.

- Stage 1: Tighten the bolts to 13 Nm (10 lb.ft).
- Stage 2: Tighten the bolts a further 45 degrees.

21. Rotate the crankshaft clockwise 2 complete revolutions.

22. CAUTION: Make sure the special tool is fully located in the flywheel.

Check the timing by inserting the special tool in the CKP sensor hole.

23. Check the camshaft timing by inserting a suitable 6 mm bar through the holes in the camshaft sprockets

24. Remove the special tool.

25. Remove the 6 mm bars.

26. Install the CKP sensor .
For additional information, refer to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

27. Install the timing cover.
For additional information, refer to: Timing Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

28. Install the valve cover.

For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

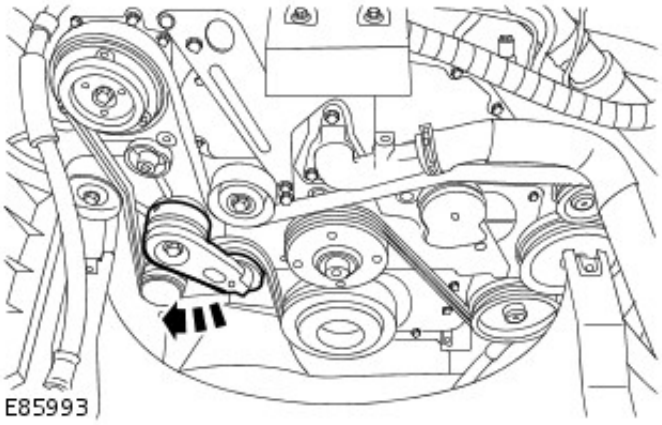
29. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Crankshaft Pulley

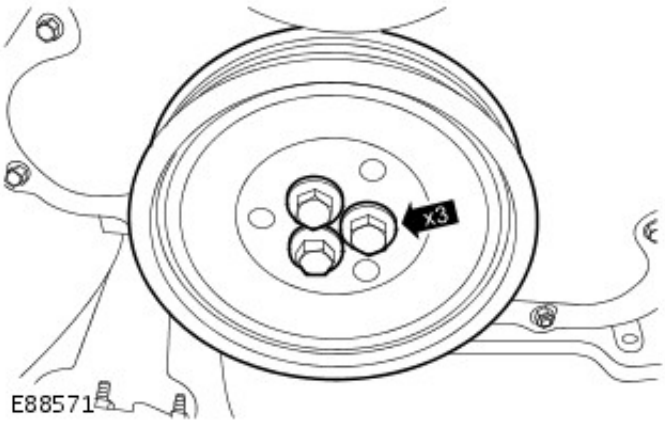
In-vehicle Repair

Removal

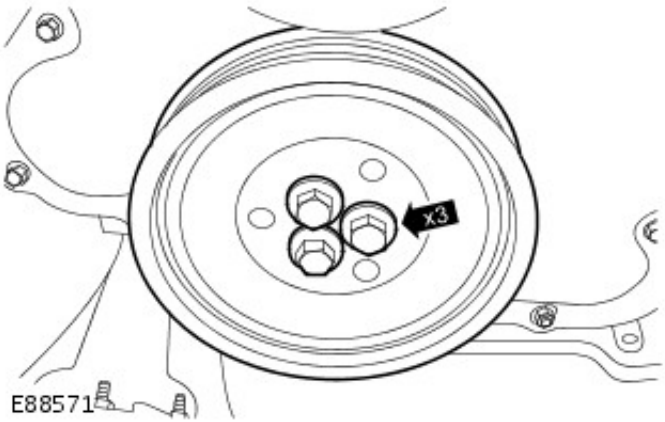
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the cooling fan.
   For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Release the tension from the accessory drive belt.
   - Rotate the accessory drive belt tensioner clockwise.



4. Remove the crankshaft pulley.
   - Remove and discard the 3 bolts.



Installation



1. CAUTION: New crankshaft pulley bolts must be installed.

• NOTE: New crankshaft pulley bolts must be installed.

• NOTE: Clean the component mating faces.

Install the crankshaft pulley.

- Stage 1: Tighten the bolts to 45 Nm (33 lb.ft).
- Stage 2: Tighten the bolts a further 90 degrees.

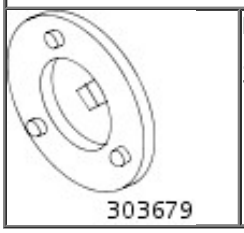
2. Secure the accessory drive belt.
   - Rotate the accessory drive belt tensioner clockwise.
3. Install the cooling fan.

For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

4. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

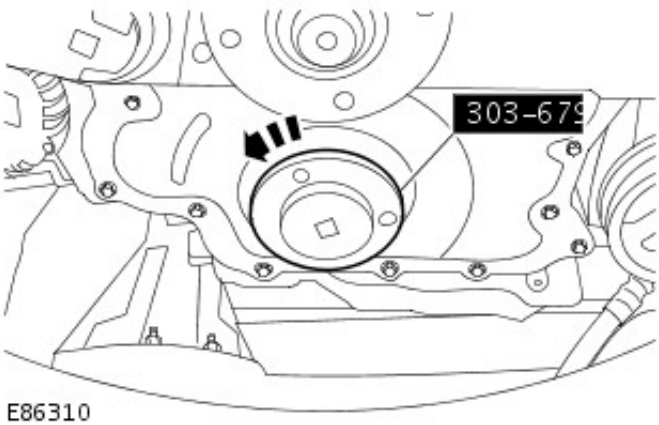
Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Crankshaft Front Seal

In-vehicle Repair

Special Tool(s)	
 303679	Remover/Installer, Front Oil Seal 303-679 (21-238)

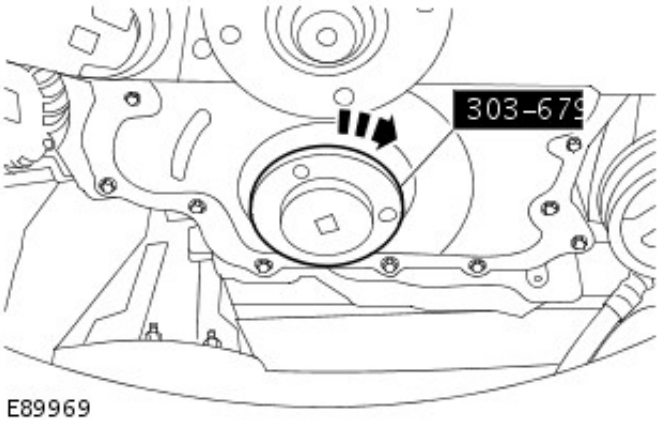
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the crankshaft pulley.
   For additional information, refer to: Crankshaft Pulley (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
3. Using the special tool, remove and discard the crankshaft front oil seal.



E86310

Installation



E89969

1. NOTE: Clean the component mating faces.

• NOTE: Install a new crankshaft front oil seal.

• NOTE: A new crankshaft front oil seal is supplied with an alignment sleeve that will be pushed out during installation.

Using the special tool, install the crankshaft front oil seal.

2. Install the crankshaft pulley.
   For additional information, refer to: Crankshaft Pulley (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
3. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Crankshaft Rear Seal

In-vehicle Repair

Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

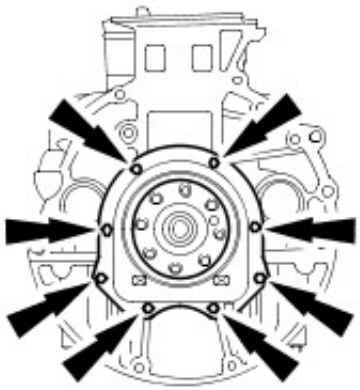
Raise and Support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the flywheel.
For additional information, refer to: Flywheel (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

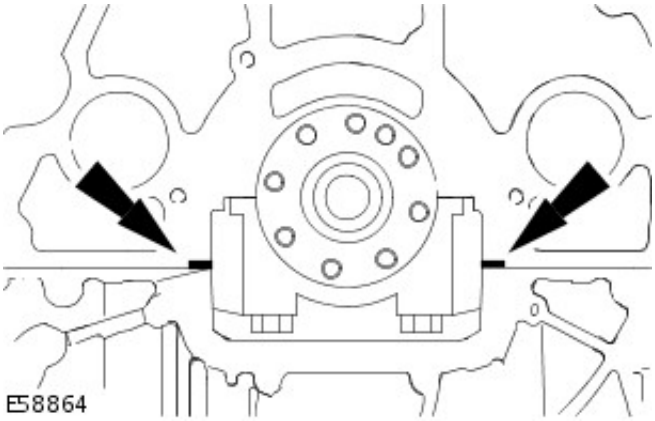
4. Remove and discard the crankshaft rear seal.

- Remove and discard the 8 bolts.



TIE0012994

Installation



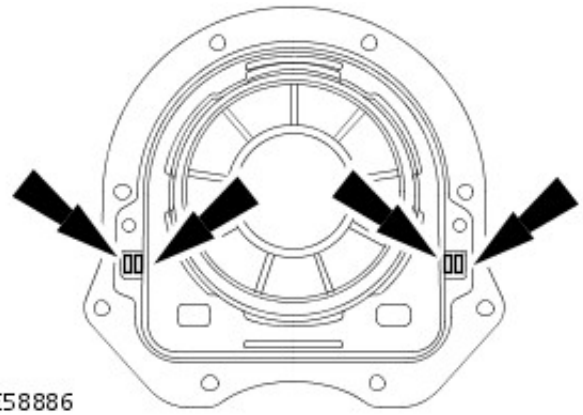
E58864

1. CAUTION: A new crankshaft rear seal is supplied with an alignment sleeve that must not be removed until the crankshaft rear seal is fully installed. Failure to follow this instruction may result in damage to the vehicle.

• NOTE: Clean the component mating faces.

Check the 2 foam pads are located on the ladder frame gasket.

- If the ladder frame gasket tabs are present, trim using a suitable tool flush to the engine block and ladder frame.
- Apply a thin layer of sealant to the areas shown.



E58886

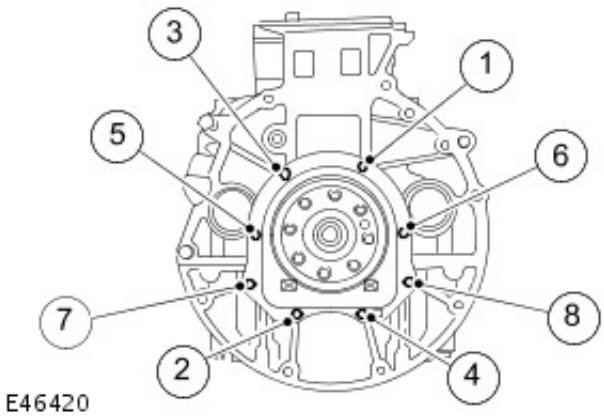
2. CAUTIONS:

Install the new crankshaft rear seal within five minutes of applying the recommended sealant.

Do not add the sealant anywhere other than the area shown.

Using the recommended sealant completely fill the square areas shown.
For additional information, refer to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

3. Install the crankshaft rear seal.



- Tighten the bolts in the sequence shown to 10 Nm (7 lb.ft).

4. Remove and discard the crankshaft rear seal alignment sleeve.

5. Install the flywheel.
For additional information, refer to: Flywheel (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cylinder Head
In-vehicle Repair

Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

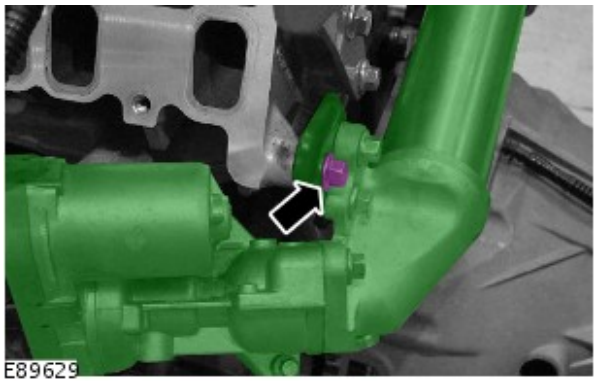
3. Remove the camshafts.
For additional information, refer to: Camshafts (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

4. Remove the intake manifold.
For additional information, refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

5. NOTE: Engine shown removed for clarity.

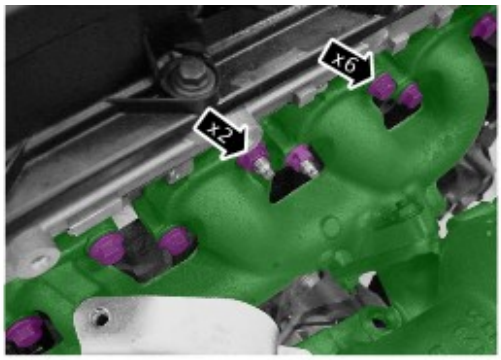
Release the exhaust gas recirculation (EGR) cooler.

- Remove the bolt.


E89629

6. Release the exhaust manifold.

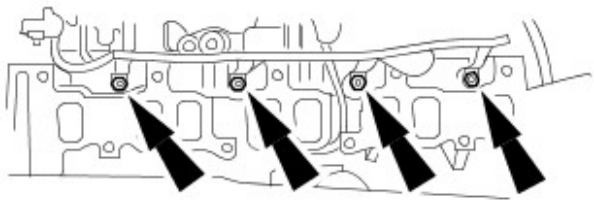
- Remove the 6 bolts.
- Remove and discard the 2 nuts.
- Remove and discard the 2 studs.
- Remove and discard the gasket.

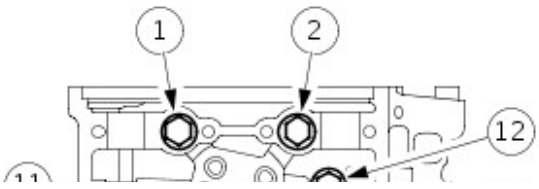


E89631

7. Release the glow plug wiring harness.

- Remove the 4 nuts.

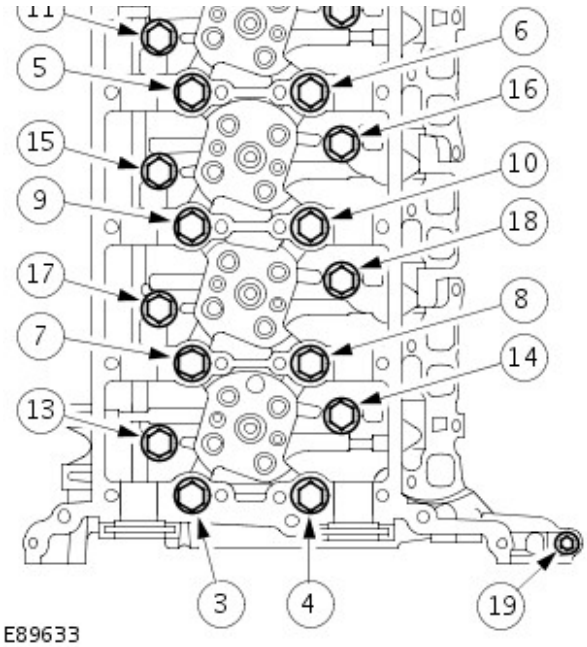

E89632



8. CAUTION: The cylinder head must not be placed face down. Failure to follow this instruction may result in damage to the vehicle.

With assistance, carefully remove the cylinder head.

- Remove and discard the bolts numbered 1 through 18.

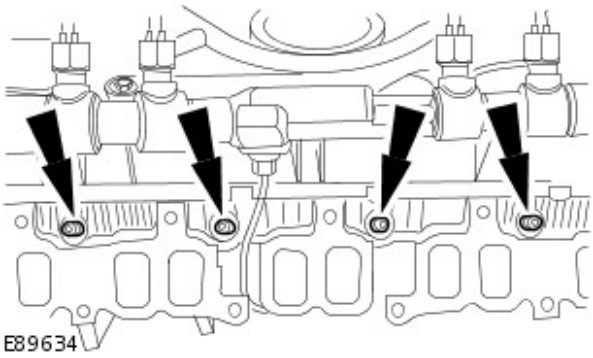


E89633

- Remove bolt 19.
- Remove and discard the gasket.

9. NOTE: Do not dismantle further if component is removed for access only.

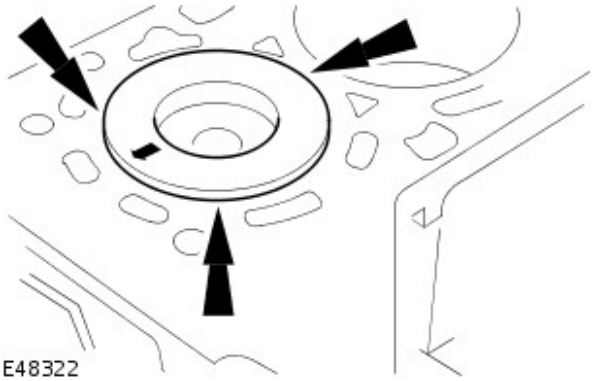
Remove the 4 glow plugs.


E89634

Installation

1. Install the glow plugs.

- Tighten the glow plugs to 12 Nm (9 lb.ft).


E48322

2. NOTE: Clean the component mating face.

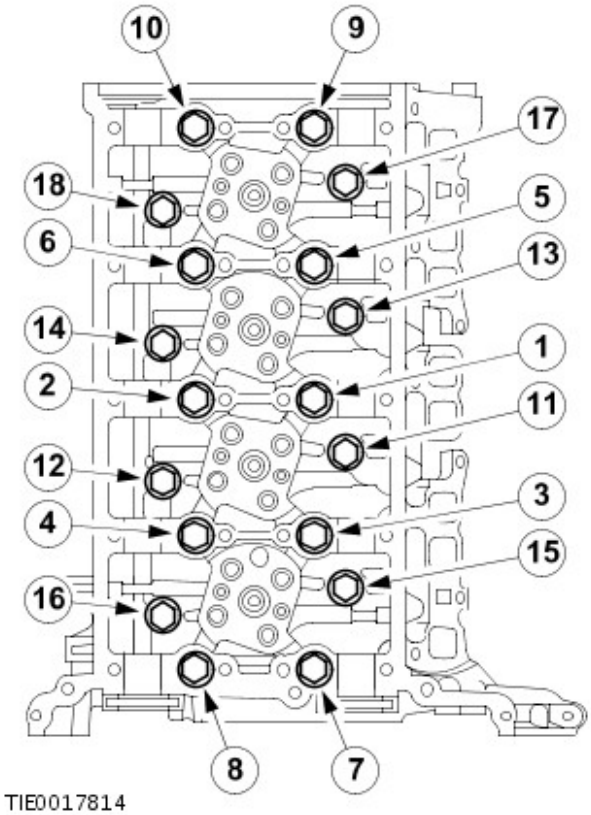
• NOTE: Measure the piston protrusion of each cylinder at top dead center (TDC).

Measure the distance between the piston crown and the cylinder block at the points indicated.

3. Determine the cylinder head gasket thickness.
For additional information, refer to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

4. CAUTION: The thickness of the new cylinder head gasket depends on the piston protrusion (hole/tooth marked).

Install a new cylinder head gasket.



TIE0017814

5. CAUTION: Install new cylinder head bolts.

• NOTE: Clean the component mating face.

Install the cylinder head.

- Tighten the bolts in the sequence shown in six stages.
- Stage 1: Tighten bolts 1 through 10 to 20 Nm.
- Stage 2: Tighten bolts 11 through 18 to 10 Nm.
- Stage 3: Tighten bolts 1 through 10 to 40 Nm.
- Stage 4: Tighten bolts 11 through 18 to 20 Nm.
- Stage 5: Tighten bolts 1 through 10 to 180 degrees.
- Stage 6: Tighten bolts 11 through 18 to 180 degrees.
- Stage 7: Tighten the M6 bolt to 10 Nm (7 lb.ft).

6. Secure the glow plug wiring harness.

- Tighten the nuts to 3 Nm (2 lb.ft).

7. NOTE: Clean the component mating faces.

Secure the exhaust manifold.

- Install a new gasket.
- Tighten the new studs to 20 Nm (15 lb.ft).
- Tighten the new nuts to 40 Nm (30 lb.ft).
- Tighten the bolts to 40 Nm (30 lb.ft).

8. Secure the EGR cooler.

- Tighten the bolt to 20 Nm (15 lb.ft).

9. Install the intake manifold.
For additional information, refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

10. Install the camshafts.
For additional information, refer to: Camshafts (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

11. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Mount LH

In-vehicle Repair

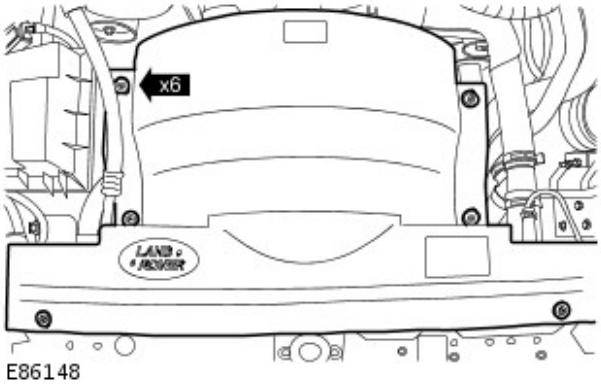
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the hood.
For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

3. Remove the cooling fan upper shroud.

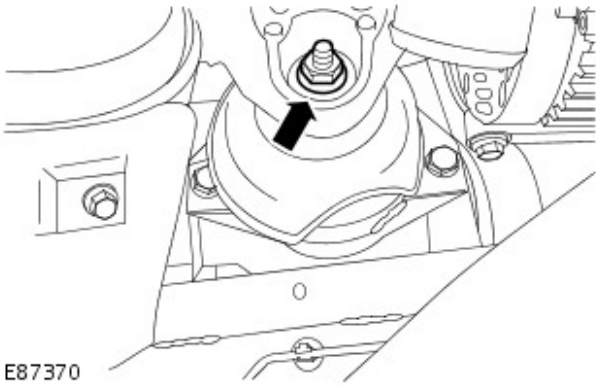
- Release the 6 clips.



E86148

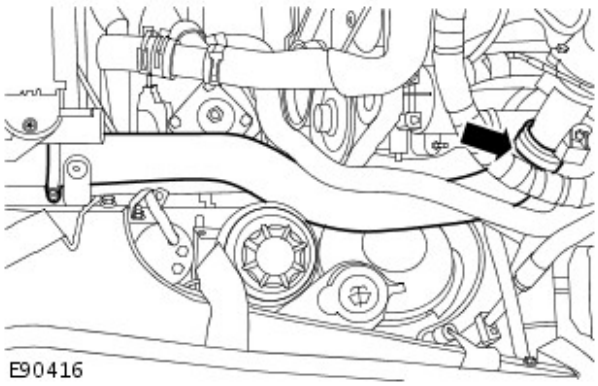
4. Remove the air cleaner outlet pipe.
For additional information, refer to: Air Cleaner Outlet Pipe (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

5. Remove the RH engine mount nut.


E87370

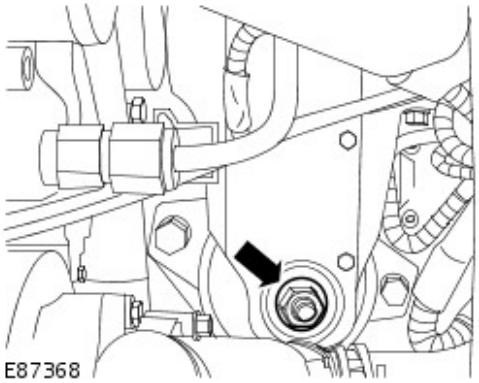
6. Disconnect the charge air cooler outlet hose.

- Loosen the clip.

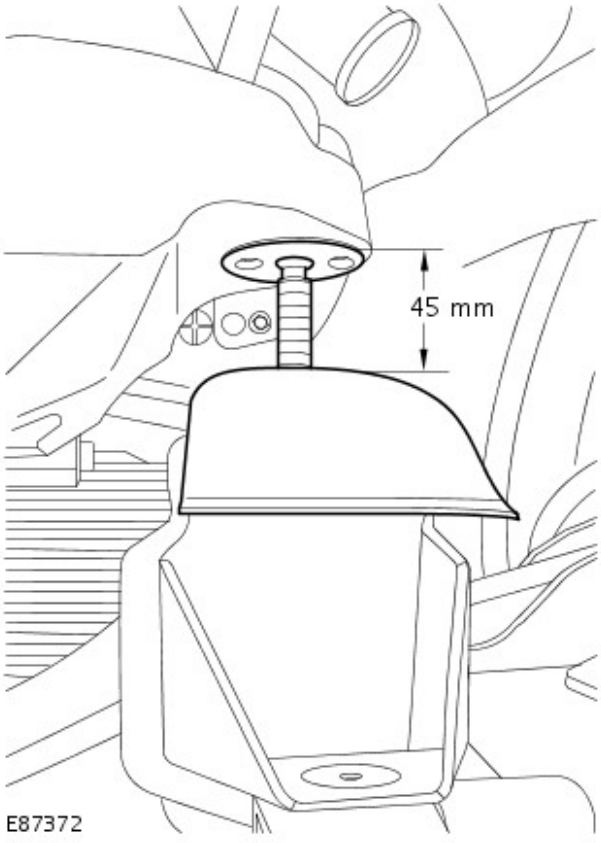

E90416

7. Remove the LH engine mount nut.

7. Remove the LH engine mount nut.

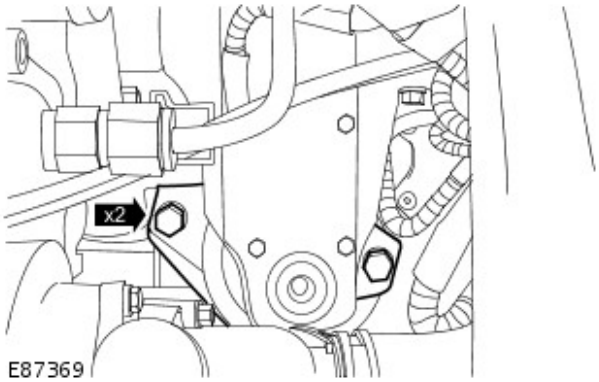


8. Using a suitable hydraulic jack, raise the engine to a maximum of 45 mm (1.77 inches).



9. Remove the LH engine mount.

- Remove the 2 bolts.

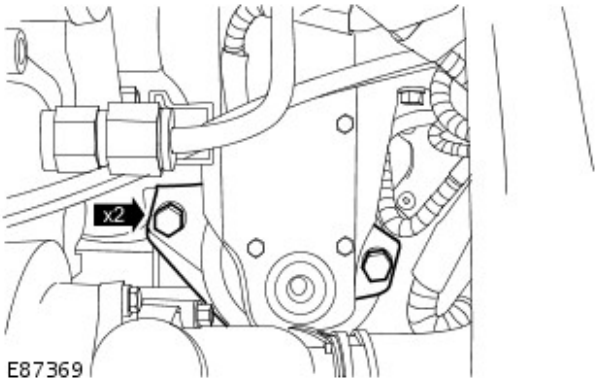


Installation

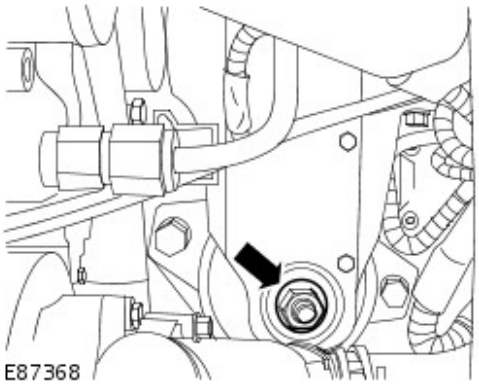
1. To install, reverse the removal procedure.

1. To install, reverse the removal procedure.

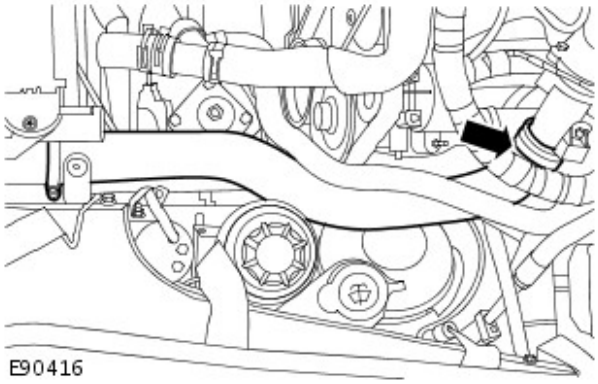
- Tighten to 80 Nm (59 lb.ft).



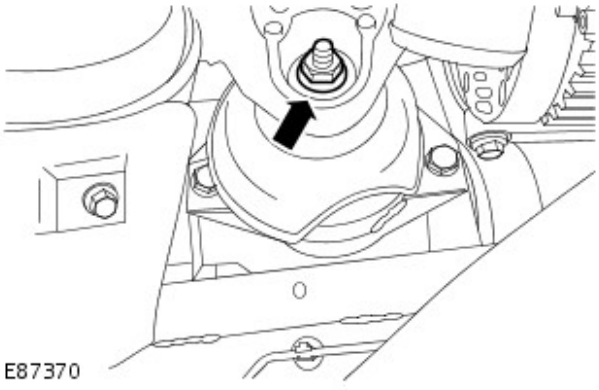
2. Tighten to 80 Nm (59 lb.ft).



3. Tighten to 3 Nm (2 lb.ft).



4. Tighten to 80 Nm (59 lb.ft).



5. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Mount RH

In-vehicle Repair

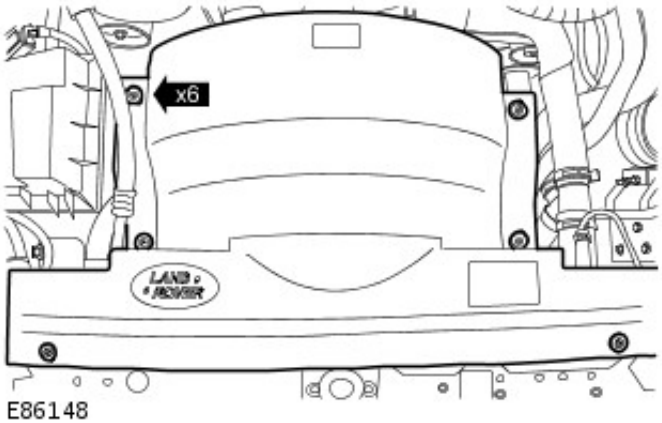
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the hood.
For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

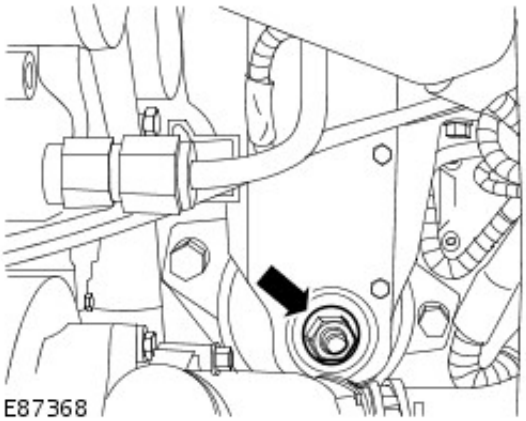
3. Remove the cooling fan upper shroud.

- Release the 6 clips.



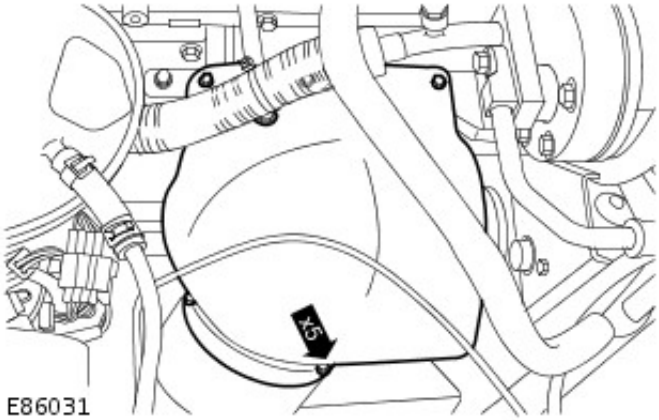
E86148

4. Remove the LH engine mount nut.


E87368

5. Remove the turbocharger heat shield.

- Remove the 5 bolts.

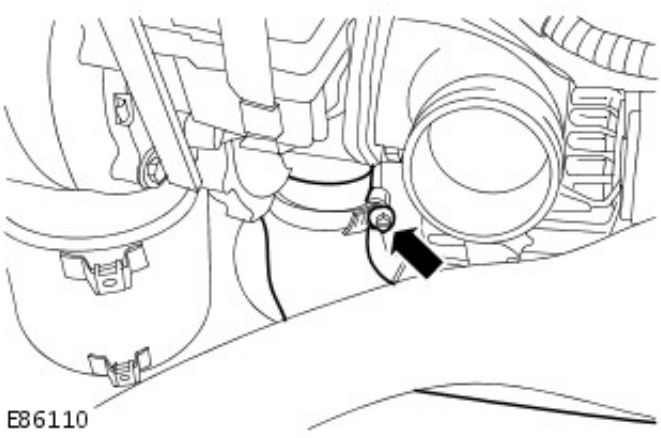


E86031

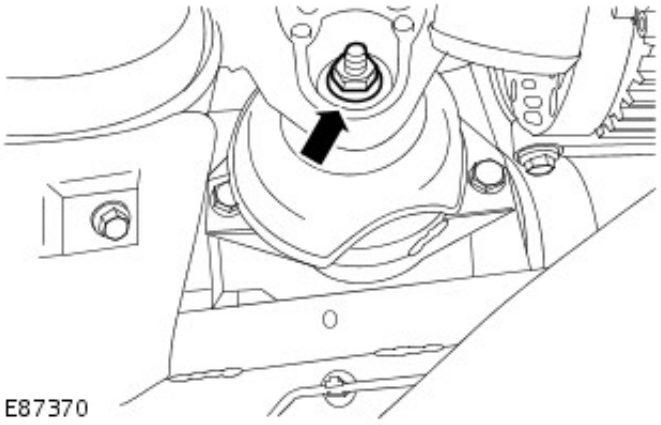
6. Remove the air cleaner outlet pipe.
For additional information, refer to: Air Cleaner Outlet Pipe (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

7. Disconnect the charge air cooler inlet hose.

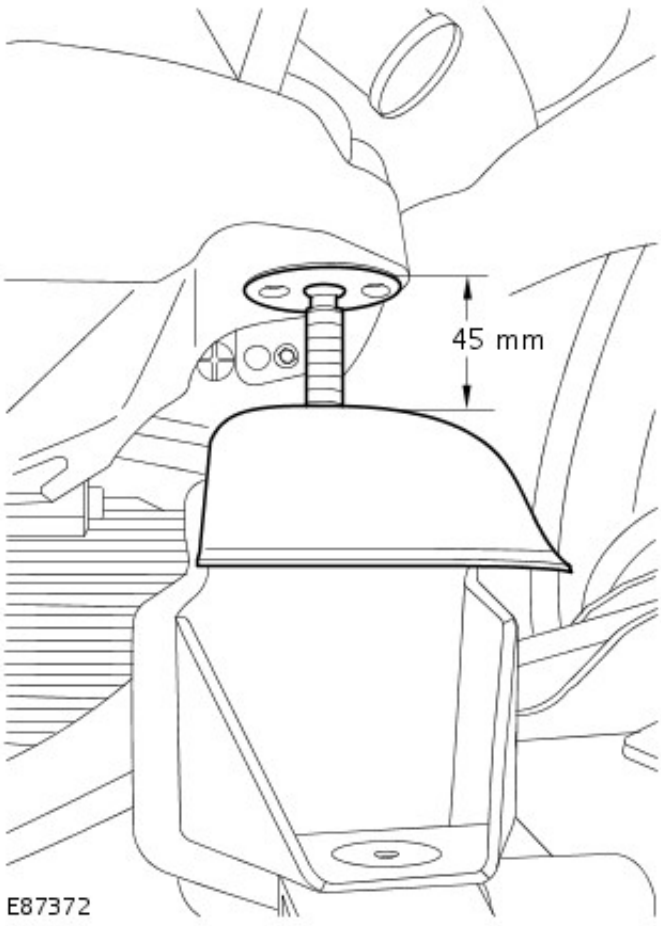
7. Disconnect the charge air cooler inlet hose.
   - Release the clip.



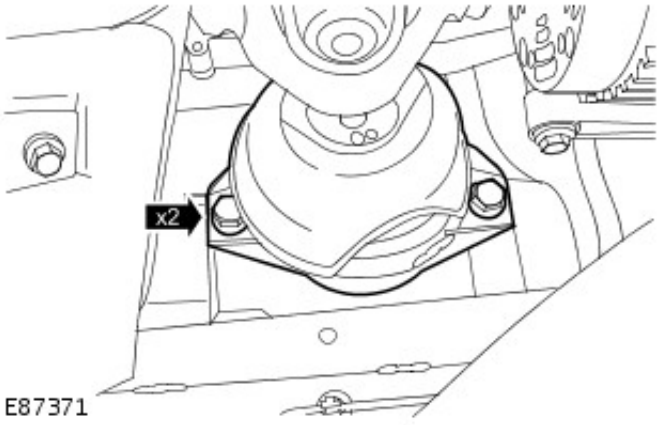
8. Remove the RH engine mount nut.



9. Using a suitable hydraulic jack, raise the engine to a maximum of 45 mm (1.77 inches).



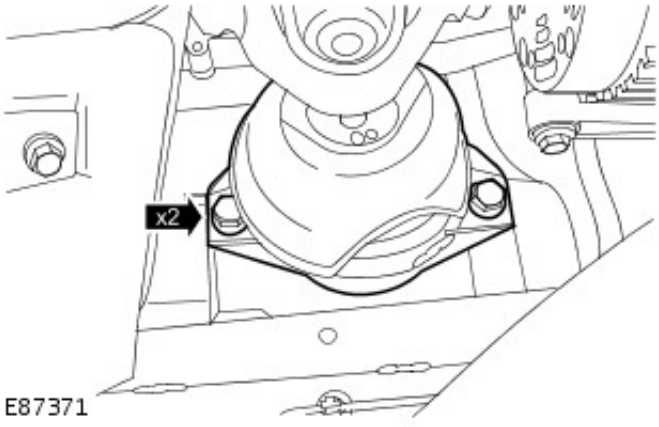
10. Remove the RH engine mount.



- Remove the 2 bolts.

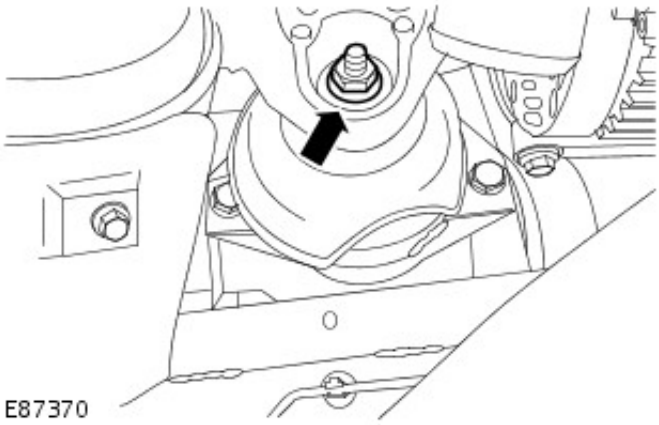
Installation

1. To install, reverse the removal procedure.

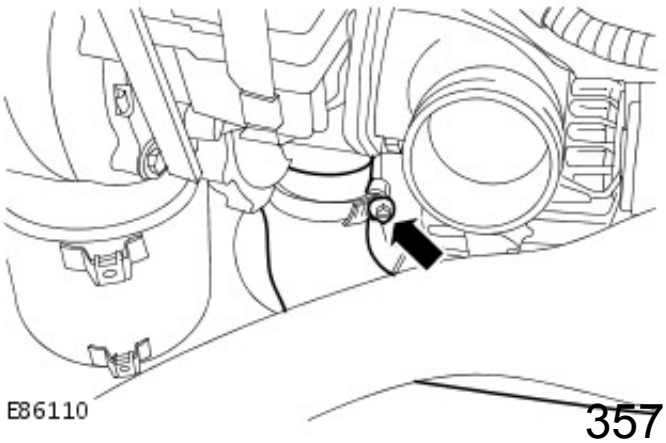


- Tighten to 80 Nm (59 lb.ft).

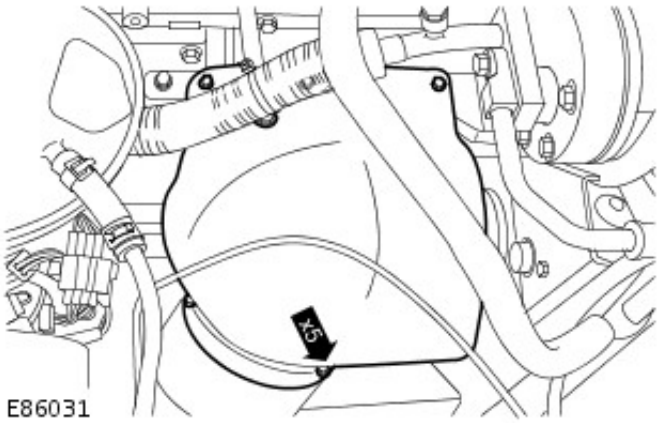
2. Tighten to 80 Nm (59 lb.ft).



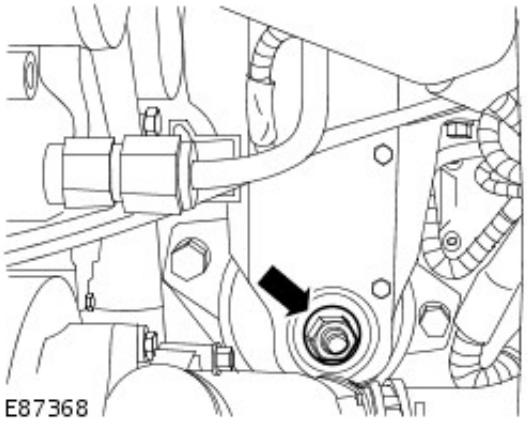
3. Tighten to 3 Nm (2 lb.ft).



4. Tighten to 10 Nm (7 lb.ft).



5. Tighten to 80 Nm (59 lb.ft).



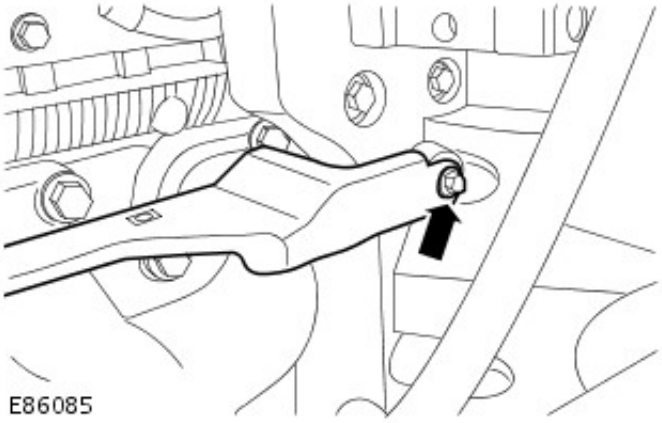
6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Exhaust Manifold

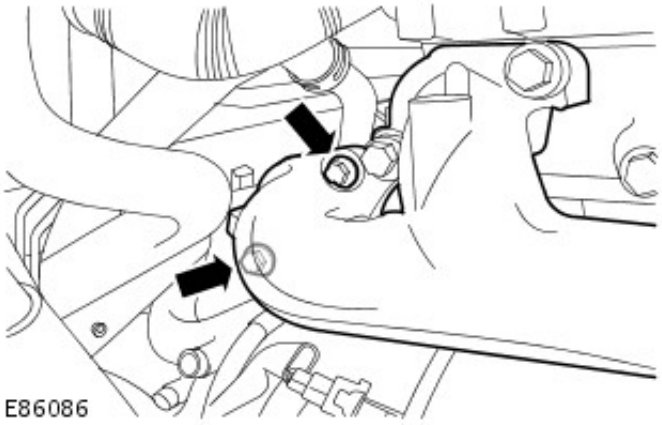
In-vehicle Repair

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the turbocharger.
   For additional information, refer to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Remove the turbocharger heat shield bracket.
   - Remove the bolt.

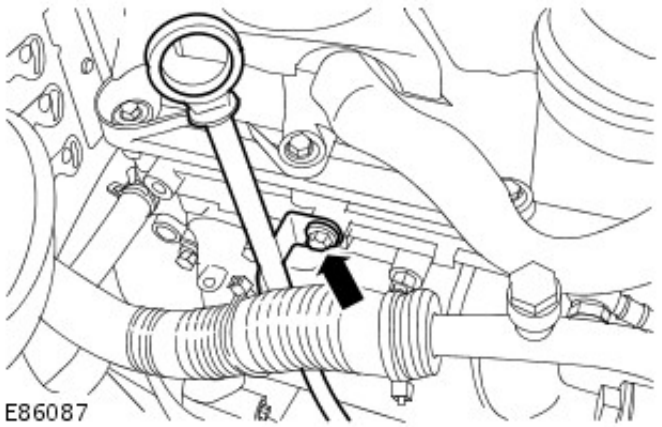


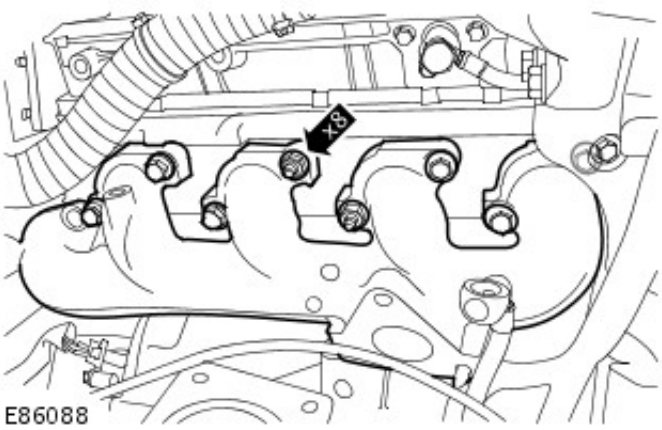
4. Remove the 2 exhaust manifold to exhaust gas recirculation (EGR) cooler bolts.



5. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Remove the oil level indicator and oil level tube.
   - Remove and discard the O-ring seal.



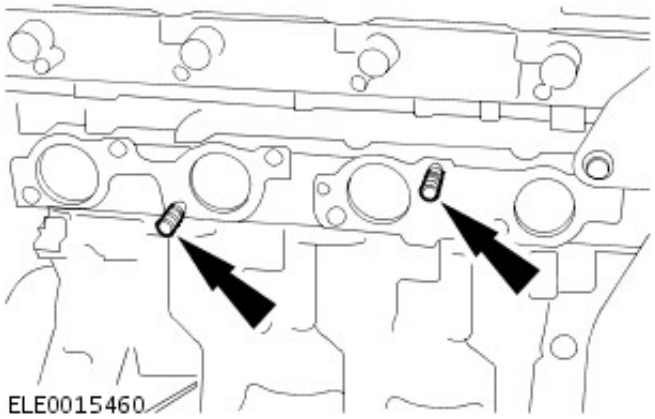


6. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the exhaust manifold.

- Remove the 6 bolts and 2 nuts.
- Remove and discard the exhaust manifold gasket.

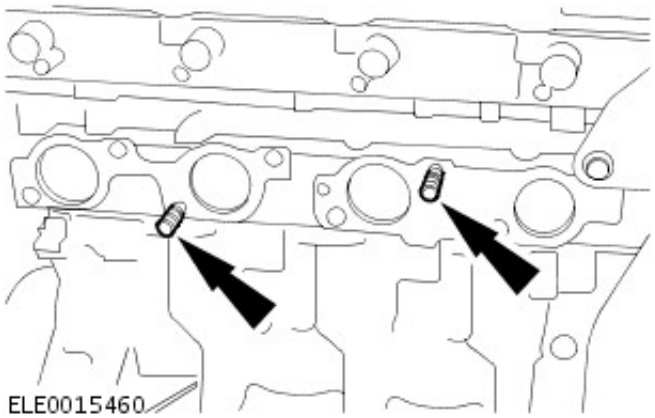
7. Remove and discard the 2 exhaust manifold studs.



Installation

1. Install new exhaust manifold studs.

- Tighten to 20 Nm (14 lb.ft).

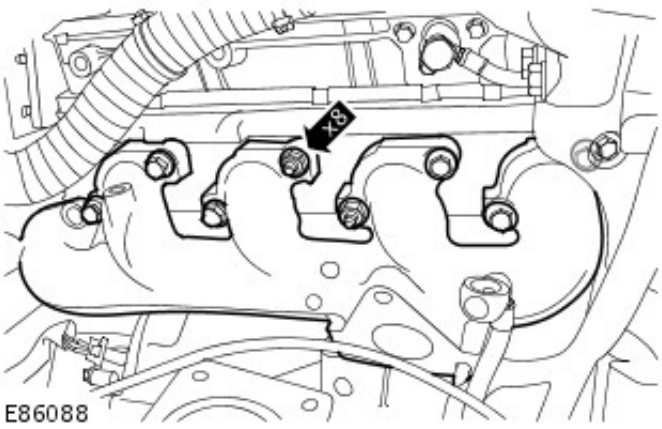


2. NOTE: Remove and discard the blanking caps.

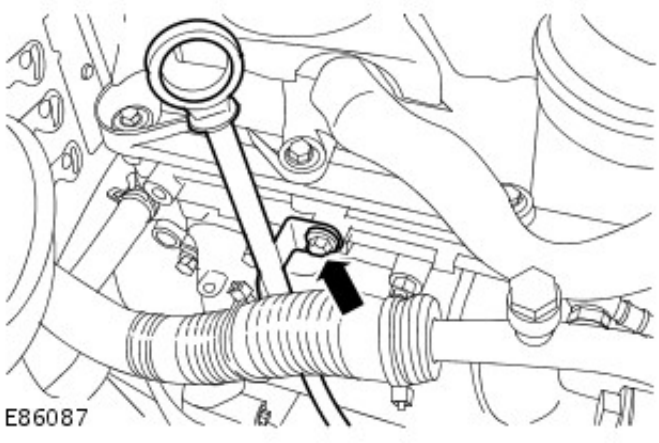
• NOTE: Clean the component mating faces.

Install the exhaust manifold.

- Install a new exhaust manifold gasket.
- Tighten to 40 Nm (30 lb.ft).

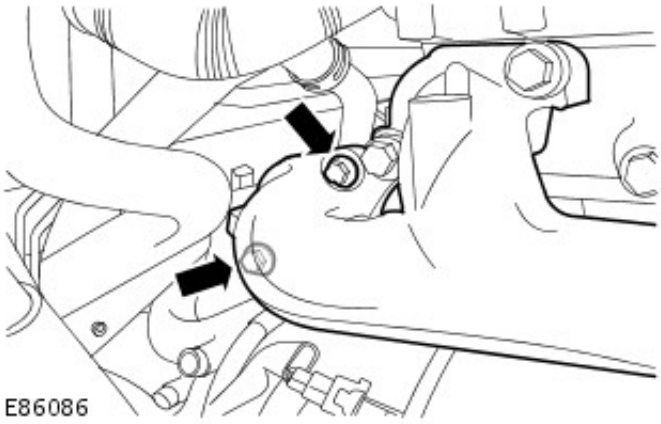


3. NOTE: Remove and discard the blanking caps.



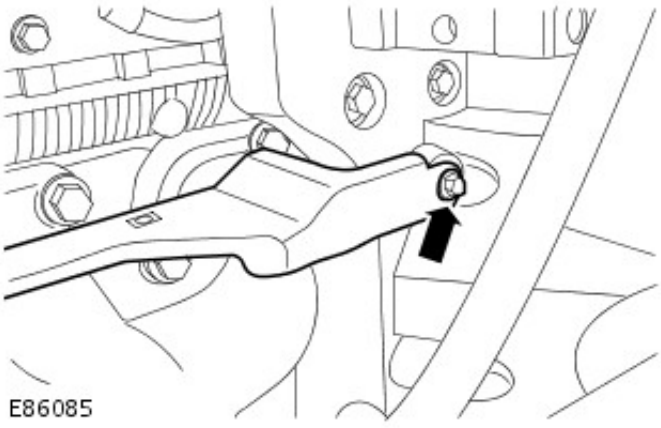
Install the oil level indicator and oil level tube.

- Install a new O-ring seal.
- Tighten to 23 Nm (17 lb.ft).



4. Install the exhaust manifold to EGR cooler bolts.

- Tighten to 23 Nm (17 lb.ft).



5. Install the turbocharger heat shield bracket.

- Tighten to 10 Nm (7 lb.ft).

6. Install the turbocharger.
For additional information, refer to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

7. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Flywheel

In-vehicle Repair

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

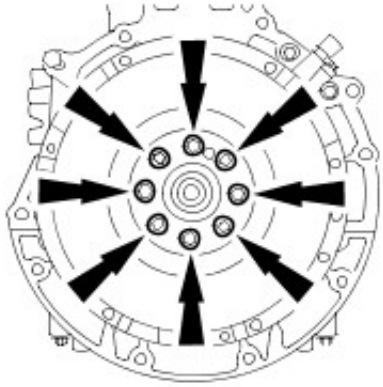
Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the clutch disc and pressure plate.
For additional information, refer to: Clutch Disc and Pressure Plate (308-01 Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

4. Remove the flywheel.

- Remove and discard the 8 bolts.



TIE0012992

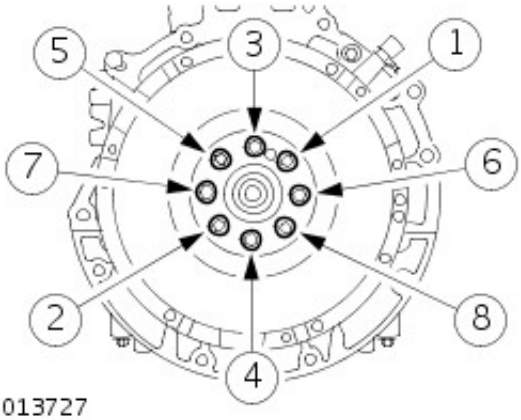
Installation

1. NOTE: Clean the component mating faces.

- NOTE: New bolts must be installed.
- NOTE: Tighten the bolts in the sequence shown.

Install the flywheel.

- Stage 1: Tighten the bolts 1 through 8 to 25 Nm (18 lb.ft).
- Stage 2: Tighten the bolts 1 through 8 to 40 Nm (30 lb.ft).
- Stage 3: Tighten the bolts 1 through 8 a further 48 degrees.



TIE0013727

2. Install the clutch disc and pressure plate.
For additional information, refer to: Clutch Disc and Pressure Plate (308-01 Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Intake Manifold

In-vehicle Repair

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

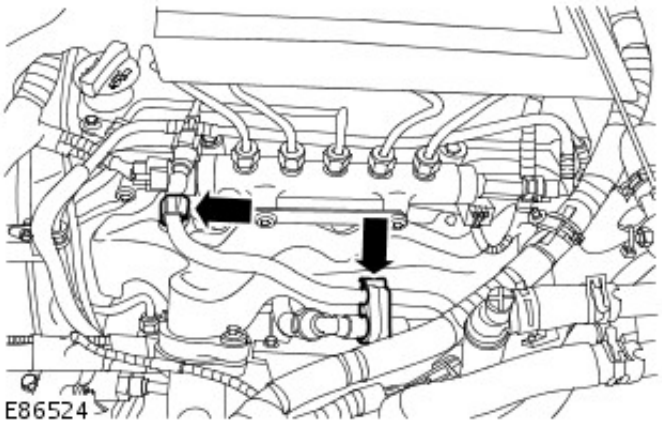
If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

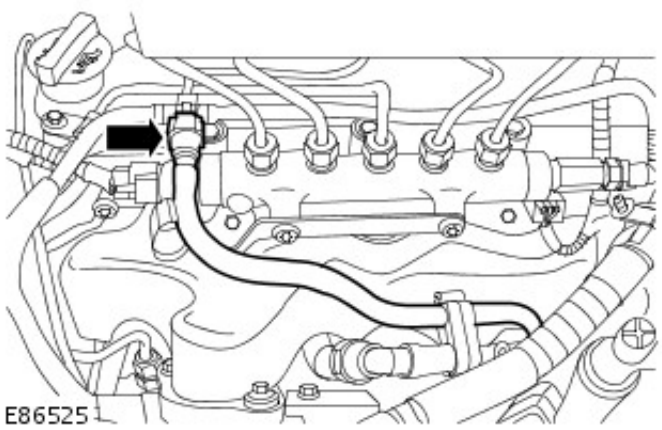
Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

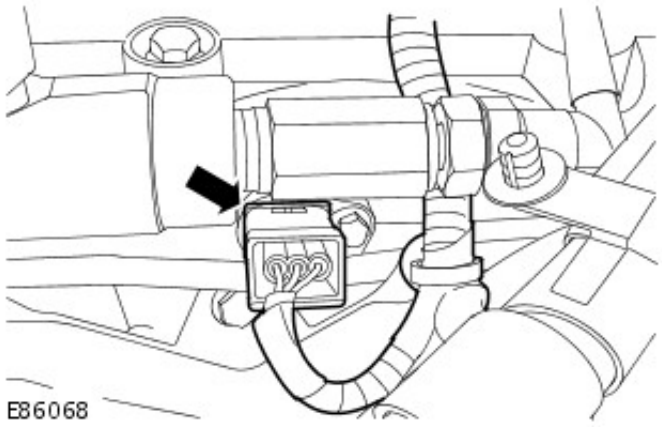
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
   For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
3. Release the fuel line.



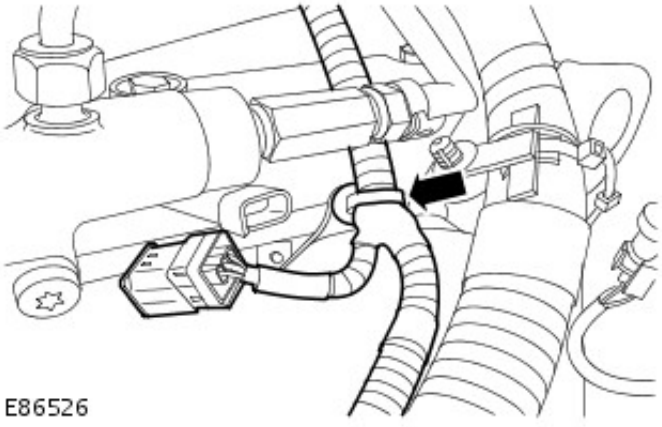


4. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

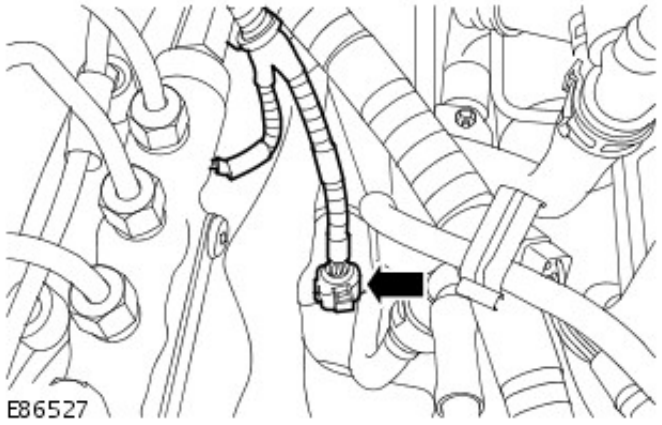
Disconnect the fuel return line.



5. Disconnect the camshaft position (CMP) sensor electrical connector.

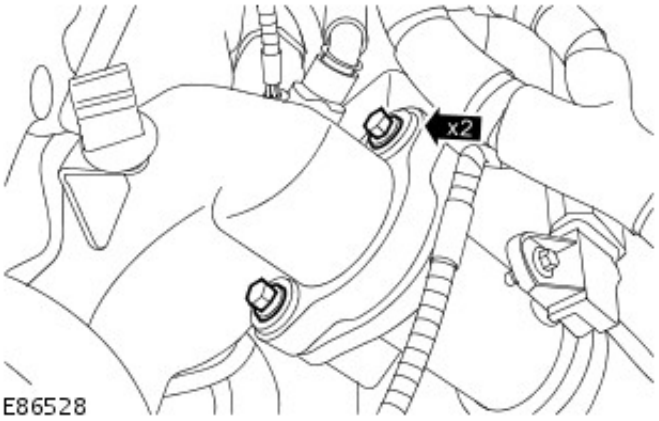


6. Release the wiring harness clip.

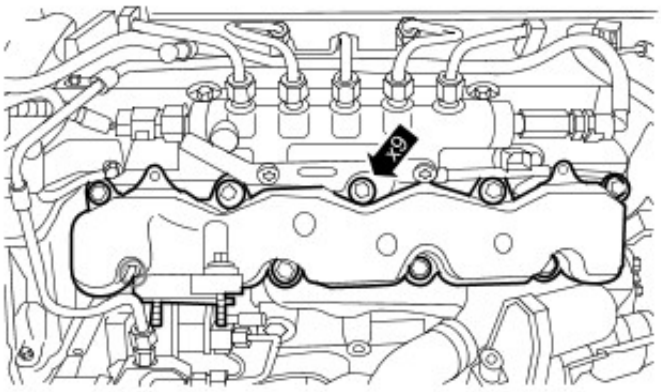


7. Disconnect the exhaust gas recirculation (EGR) valve electrical connector.

8. Remove the 2 bolts from the intake manifold.



E86528



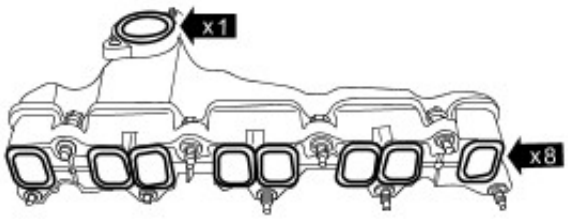
E86529

9. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the intake manifold.

- Remove the 9 bolts.

10. Remove and discard the 9 O-ring seals from the intake manifold.



E86530

Installation

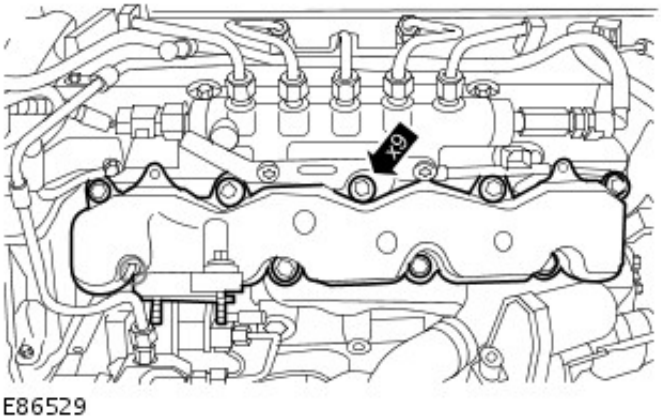
1. NOTE: Clean the component mating faces.

Install new O-ring seals to the intake manifold.

2. NOTE: Remove and discard the blanking caps.

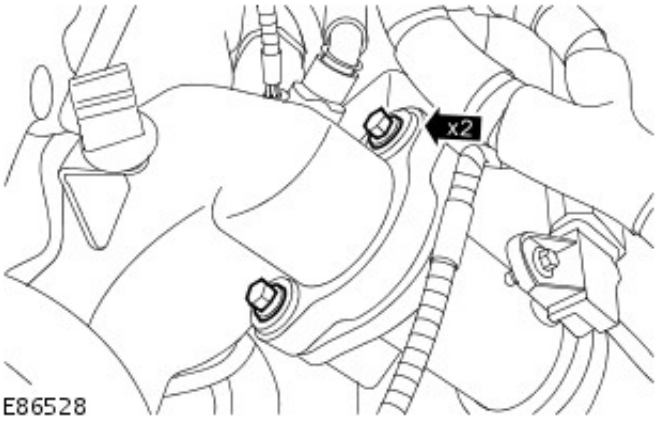
Install the intake manifold.

- Tighten the bolts to 15 Nm (11 lb.ft).



E86529

- Tighten the bolts to 10 Nm (7 lb.ft).



4. Connect the EGR valve electrical connector.

5. Connect the CMP sensor electrical connector.

- Secure the wiring harness.

6. NOTE: Remove and discard the blanking caps.

Connect the fuel return line.

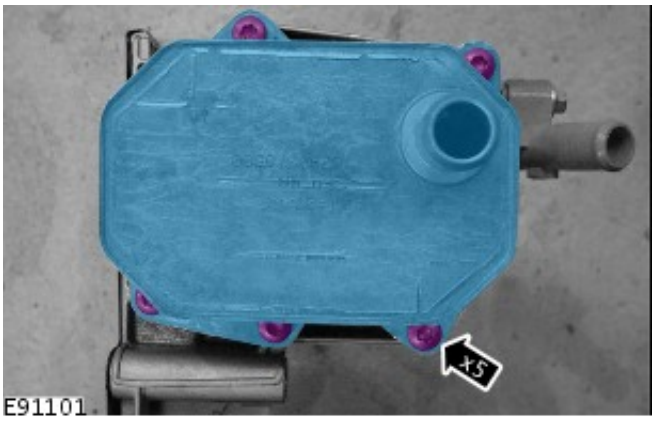
7. Secure the fuel line.

8. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Oil Cooler
In-vehicle Repair

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the oil filter housing.
   For additional information, refer to: Oil Filter Housing (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

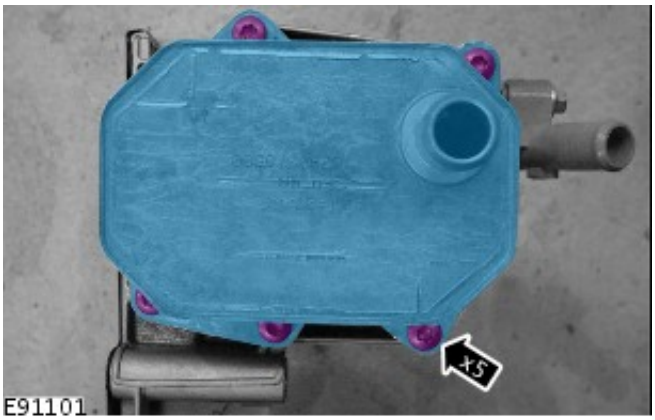


3. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Remove the oil cooler.

   - Remove the 5 bolts.
   - Remove and discard the O-ring seals.

Installation



1. NOTE: Remove and discard the blanking caps.

• NOTE: Clean the component mating faces.

• NOTE: Install a new O-ring seals.

To install, reverse the removal procedure.

- Tighten the bolts to 10 Nm (7 lb.ft).

2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Oil Filter Housing

In-vehicle Repair

Removal

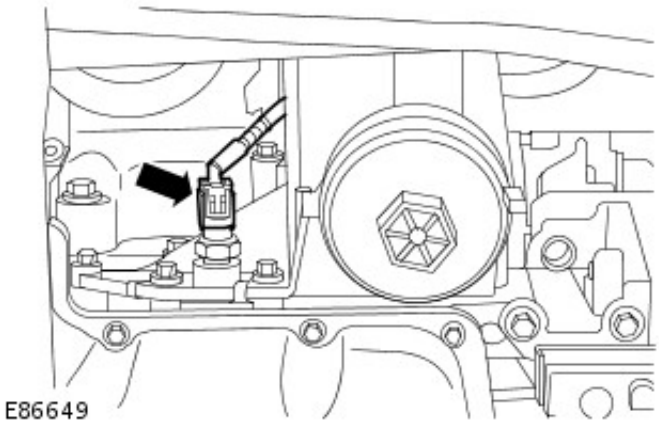
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

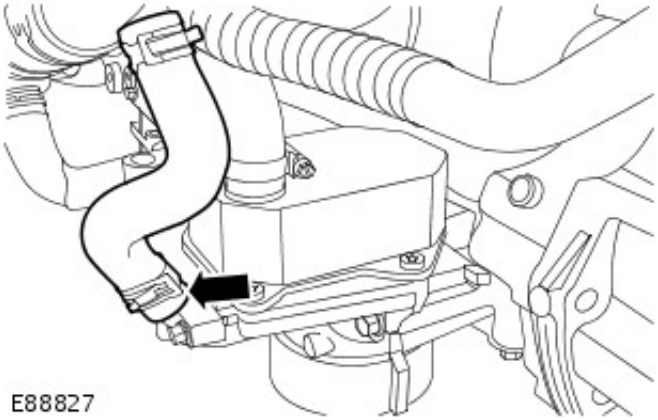
   Raise and support the vehicle.

3. Drain the cooling system.
   For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

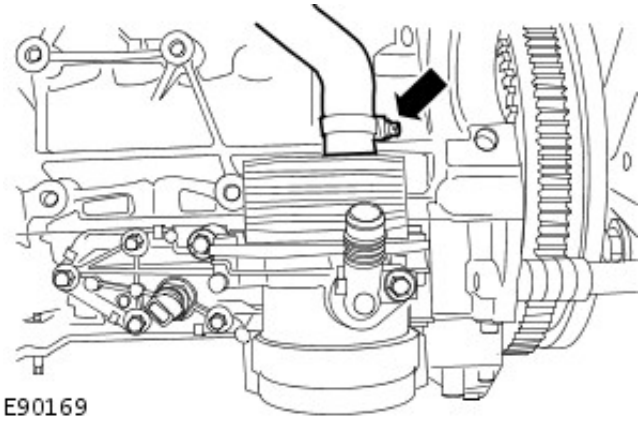
4. Disconnect the engine oil pressure (EOP) sensor electrical connector.


E86649

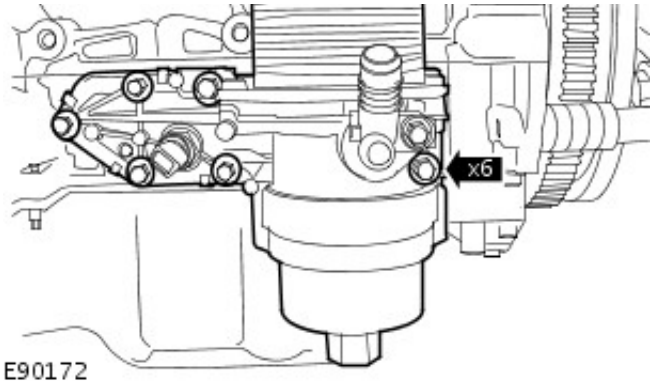
5. Disconnect the coolant hose from the engine oil cooler.
   - Release the clip.


E88827

6. Disconnect the coolant hose.
   - Release the clip.


E90169

7. CAUTION: Make sure that all openings are sealed. Use

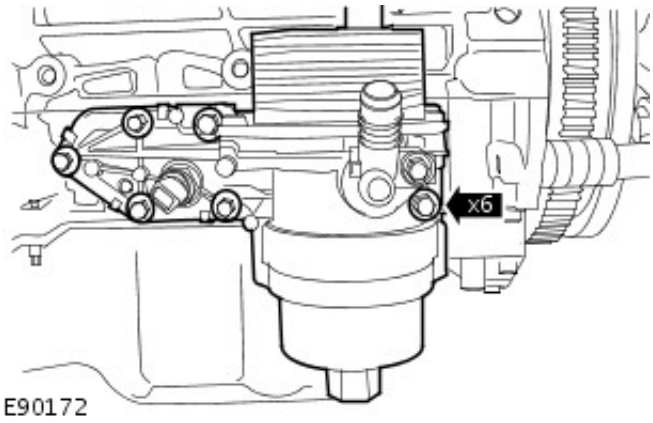


new blanking caps.

Remove the oil filter housing assembly.

- Remove the 6 bolts.
- Remove and discard the gasket.

Installation



1. NOTE: Remove and discard the blanking caps.

• NOTE: Clean the component mating faces.

• NOTE: Install a new gasket.

To install, reverse the removal procedure.

- Tighten the bolts to 23 Nm (17 lb.ft).

2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Oil Pan

In-vehicle Repair

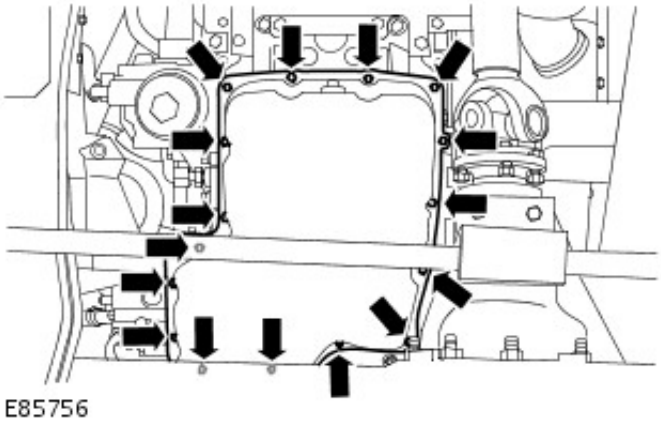
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

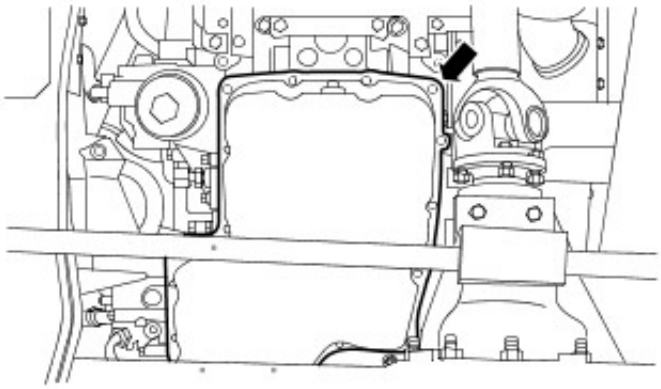
Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

2. Drain the engine oil.
For additional information, refer to: Engine Oil Draining and Filling (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

3. Remove the 16 oil pan bolts.



E85756



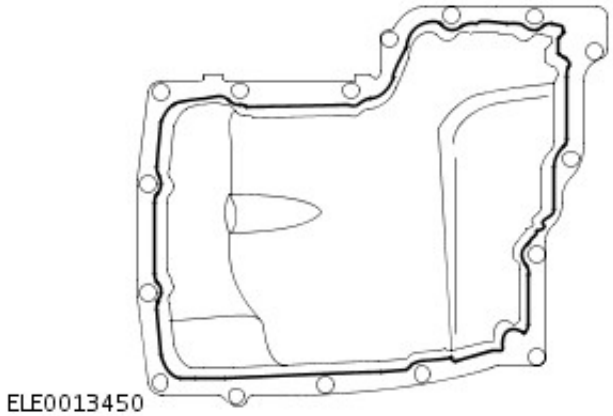
E89943

4. CAUTION: Avoid damage to the oil pan mating face. Failure to follow this instruction may cause damage to the vehicle.

• NOTE: Lubricate the suitable tool with clean engine oil.

Using a suitable tool remove and discard the oil pan.

Installation



ELE0013450

1. CAUTIONS:

Avoid damage to the oil pan mating face of the cylinder block. Failure to follow this instruction may cause damage to the vehicle.

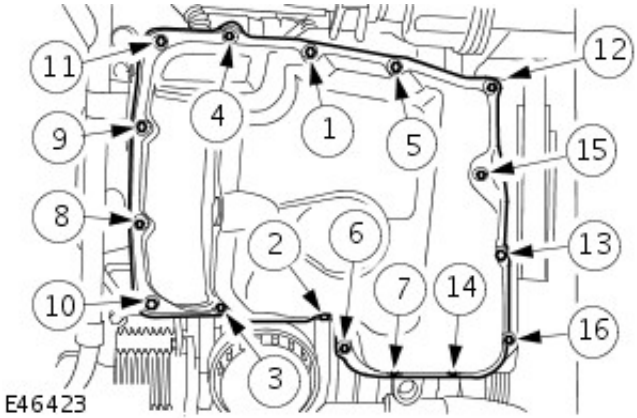
A new oil pan must be installed. Failure to follow this instruction may cause damage to the vehicle.

Install the oil pan within five minutes of applying the sealer. Failure to follow this instruction may cause damage to the vehicle.

• NOTE: Clean the cylinder block mating faces.

Apply a 3mm bead of sealer WSE-M4G323-A4 to the oil pan.

2. NOTE: Do not fully tighten the oil pan bolts at this stage.



Install the oil pan.

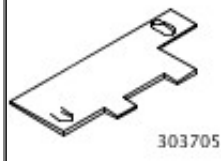
3. Tighten the oil pan bolts.

- Tighten the bolts in the sequence shown in two stages.
- Stage 1: Tighten bolts 1 through 16 to 7 Nm (5 lb.ft).
- Stage 2: Tighten bolts 1 through 16 to 14 Nm (10 lb.ft).

4. Fill the engine with engine oil.
For additional information, refer to: Engine Oil Draining and Filling (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Oil Pump

In-vehicle Repair

Special Tool(s)	
	Aligner, oil pump 303-705

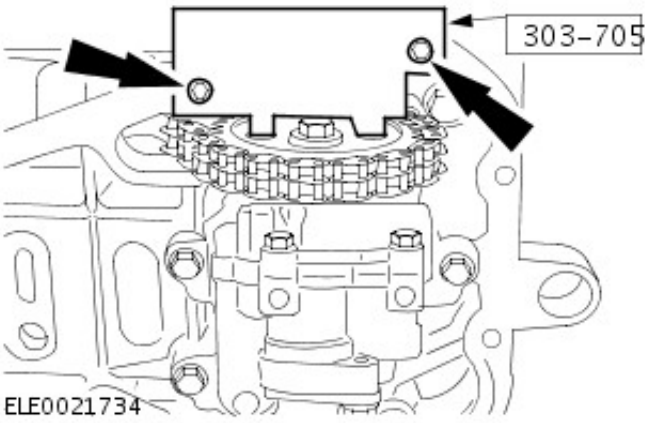
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the oil pan.
For additional information, refer to: Oil Pan (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

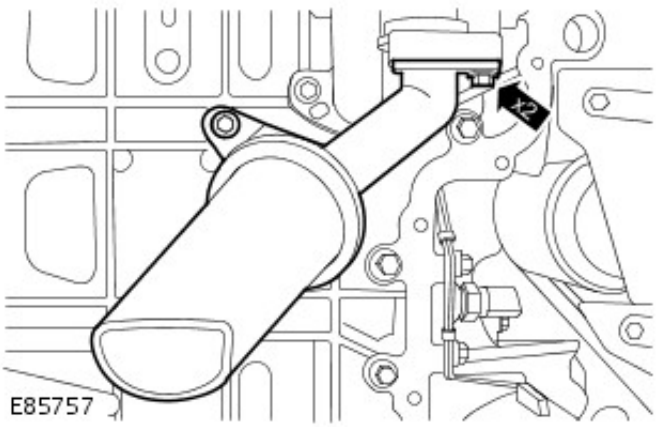
4. NOTE: The profile of the special tool must be in contact with the oil pump sprocket.



Install the special tool to the engine block and loosely install the 2 bolts.

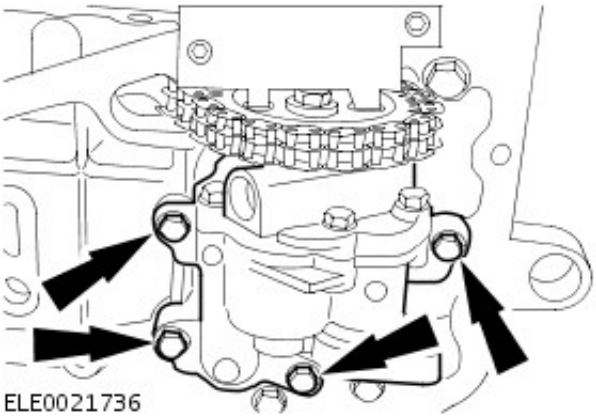
- Push the special tool against the oil pump sprocket.
- Tighten the 2 bolts.

5. Remove the oil pickup pipe.

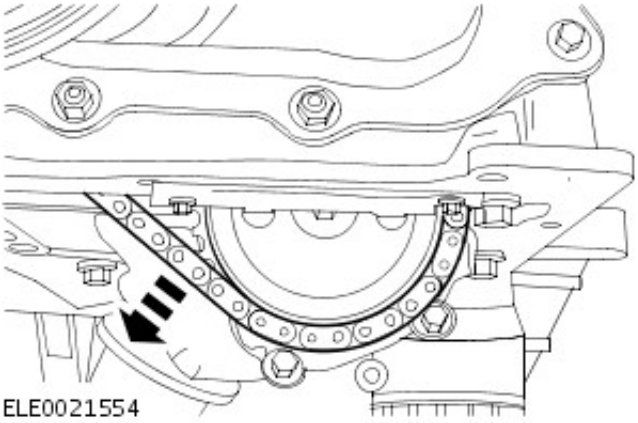


- Remove the 2 bolts.

6. Release the oil pump.


ELE0021736

- Remove the 4 bolts.


ELE0021554

7. NOTE: Engine oil will be expelled when the chain is pulled down.

Remove the oil pump.

- Pull down on the oil pump chain to release the chain from the sprocket.

Installation

1. NOTE: Do not fully tighten the oil pump bolts at this stage.

Install the oil pump.

- Install the chain on to the oil pump sprocket.
- Loosely install the oil pump bolts.

2. Secure the oil pump.

- Push the oil pump forward so that the sprocket is in contact with the special tool.
- Tighten the bolts to 10 Nm (7 lb.ft).

3. Remove the special tool.

- Remove the 2 bolts.

4. Install the oil pickup pipe.

- Tighten the bolts to 10 Nm (7 lb.ft).

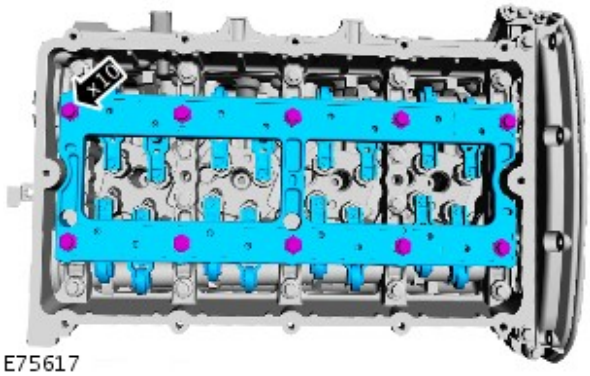
5. Install the oil pan.
For additional information, refer to: Oil Pan (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Rocker Arm
In-vehicle Repair

Removal

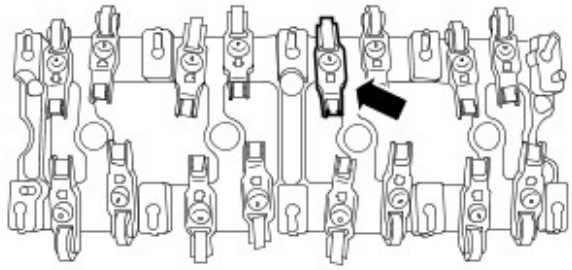
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the valve cover.
   For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
3. Remove the rocker arm carrier.
   - Remove the 10 bolts.



E75617

4. NOTE: One rocker arm shown, others similar.

   Remove the rocker arm.

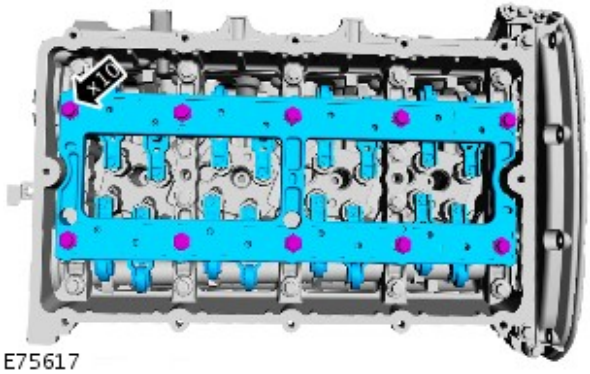

E87604

Installation

1. NOTE: Clean the component mating faces.

   Install the rocker arm.
2. NOTE: Clean the component mating faces.

   Install the rocker arm carrier.
   - Stage 1: Tighten to 10 Nm (7 lb.ft).
   - Stage 2: Tighten a further 30 degrees.

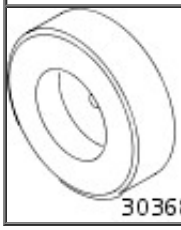


E75617

3. Install the valve cover.
   For additional information, refer to: Valve Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
4. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Timing Cover

In-vehicle Repair

Special Tool(s)	
 303682	Aligner Tool, Timing cover 303-682

Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Drain the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

4. Remove the accessory drive component bracket.
For additional information, refer to: Accessory Drive Component Bracket (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

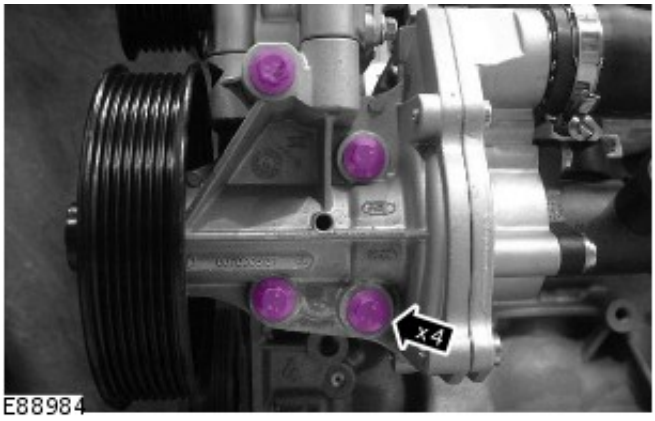
5. Reposition the cylinder head coolant outlet elbow.

E88983

- Remove the nut.
- Remove the 2 bolts.
- Remove and discard the O-ring seal.

6. Remove the crankshaft front seal.
For additional information, refer to: Crankshaft Front Seal (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

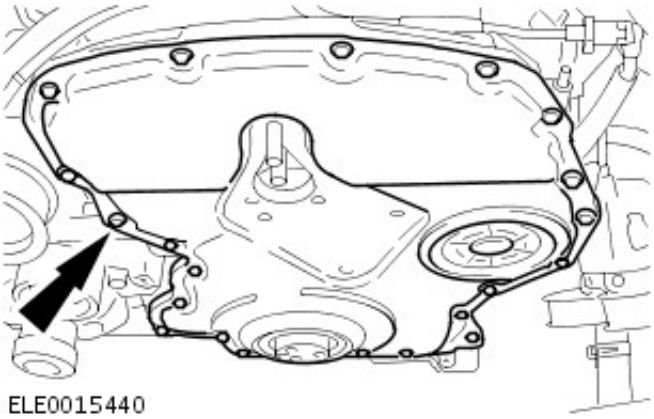
7. Reposition the coolant pump.



E88984

- Remove the 4 bolts.
- Remove and discard the gasket.

8. Using a suitable tool, remove and discard the timing cover.


ELE0015440

- Remove the 20 bolts.
- Remove the 2 nuts.

Installation

1. Clean the engine timing cover mating faces.

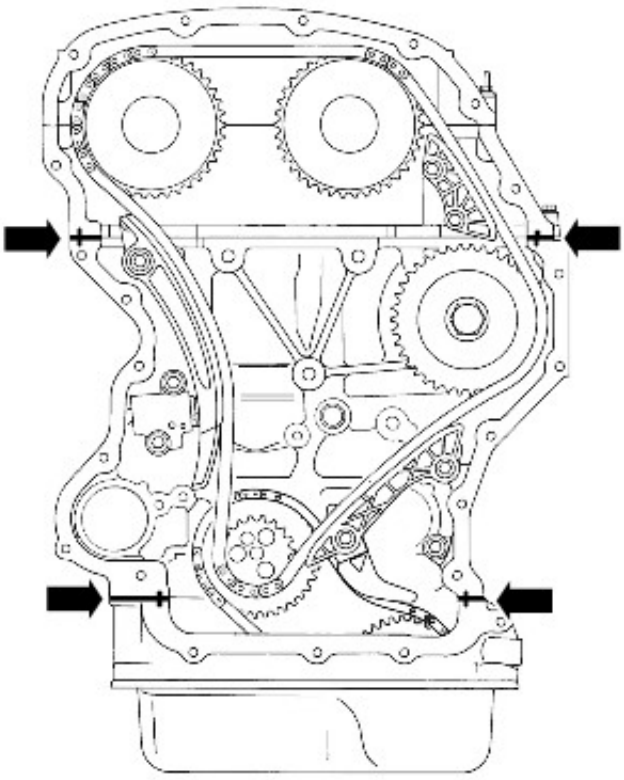
2. CAUTIONS:

⚠ A new engine timing cover must be installed. Failure to follow this instruction may result in damage to the vehicle.

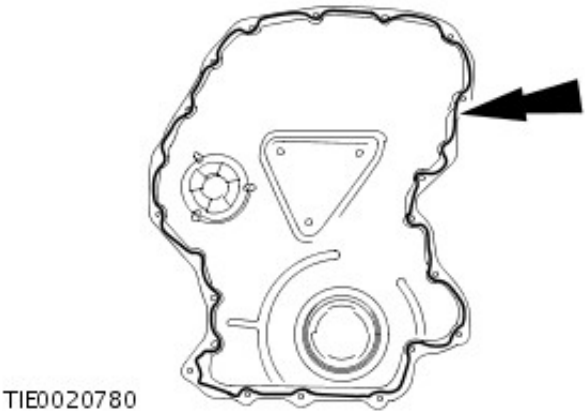
⚠ Install the engine timing cover within five minutes of applying the sealer. Failure to follow this instruction may result in damage to the vehicle.

• NOTE: Some variation in the illustrations may occur, but the essential information is always correct.

Apply a 3 mm (0.118 inch) bead of sealer to the four T-joints.

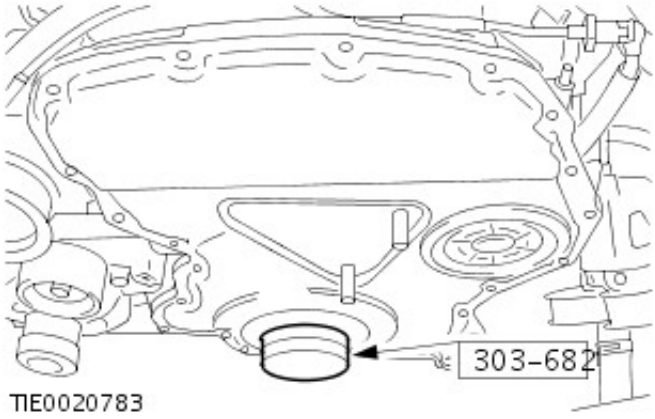

E100334

3. Apply a 3 mm (0.118 inch) bead of selaer to the engine timing cover.


TIE0020780

4. WARNING: Make sure that the engine timing cover does not come into contact with the engine until correct position is obtained.

With the aid of a second technician, position the engine timing cover.



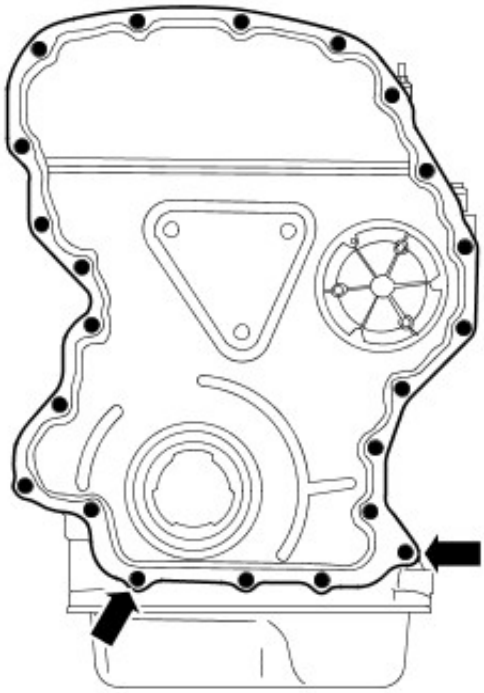
5. NOTE: Engine shown removed for clarity.

Using the special tool, align the engine timing cover.

- Intall and tighten 2 engine timing cover bolts to 6 Nm.
- Install and tighten the remaining 16 engine timing cover bolts and 2 nuts to 6 Nm.
- Slacken the engine timing cover bolts and nuts 360 degrees.
- Install the special tool.

6. Tighten the engine timing cover nuts and bolts.

- Tighten the engine timing cover nuts and bolts to 3 Nm.
- Tighten the engine timing cover nuts and bolts in the following sequence:
- Tighten the 2 bolts indicated to 11 Nm.
- Tighten the remaining nuts and bolts to 10 Nm.



7. NOTE: Clean the component mating faces.

Secure the coolant pump.

- Install a new gasket.
- Tighten the bolts to 22 Nm (16 lb.ft).

8. NOTE: Clean the component mating faces.

Secure the cylinder head coolant outlet elbow.

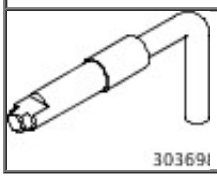
- Install new O-ring seal.
- Tighten the nut to 22 Nm (16 lb.ft).
- Tighten the bolts to 22 Nm (16 lb.ft).

9. Install the accessory drive component bracket.
For additional information, refer to: Accessory Drive Component Bracket (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

10. Connect the battery ground cable.
    For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).
11. Fill and bleed the cooling system.
    For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Timing Chain

In-vehicle Repair

Special Tool(s)	
	Timing tool, crankshaft 303-698

Removal

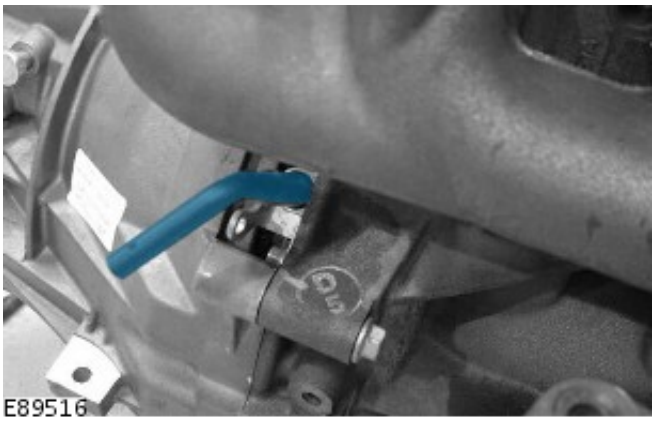
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the timing cover.
For additional information, refer to: Timing Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

4. Remove the crankshaft position (CKP) sensor.
For additional information, refer to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).



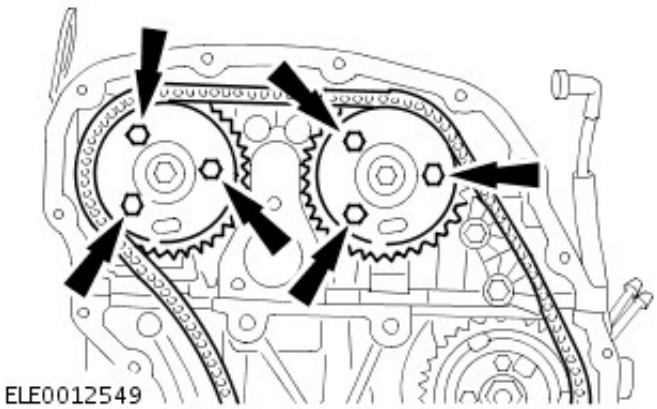
5. CAUTION: Do not turn the crankshaft when the special tool is fully located into the flywheel. Failure to follow this instruction may result in damage to the vehicle.

Rotate the crankshaft to 50 degrees before top dead center (BTDC).

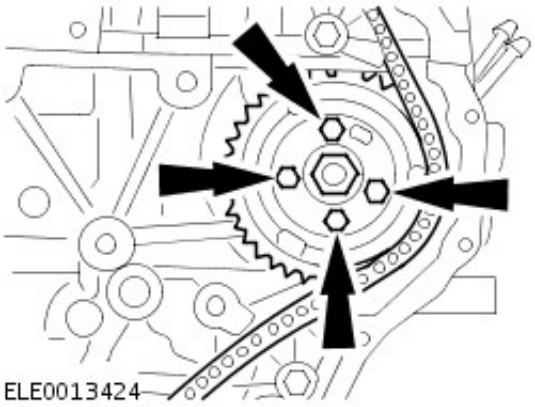
- Install the special tool through the CKP sensor hole.

6. Using suitable 6 mm bars, lock the camshaft sprockets.

7. Loosen the 6 camshaft sprocket bolts.

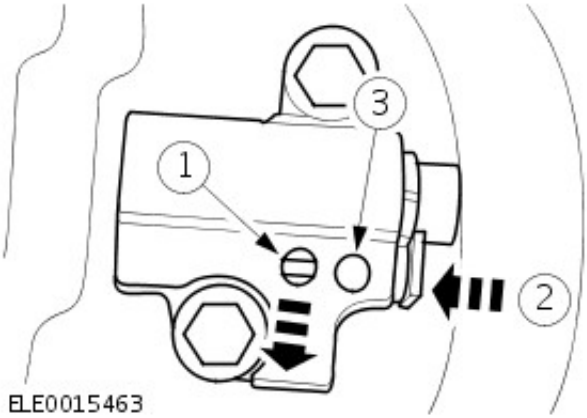


8. Loosen the 4 fuel injection pump sprocket bolts.


ELE0013424

9. Detension and lock the timing chain tensioner.

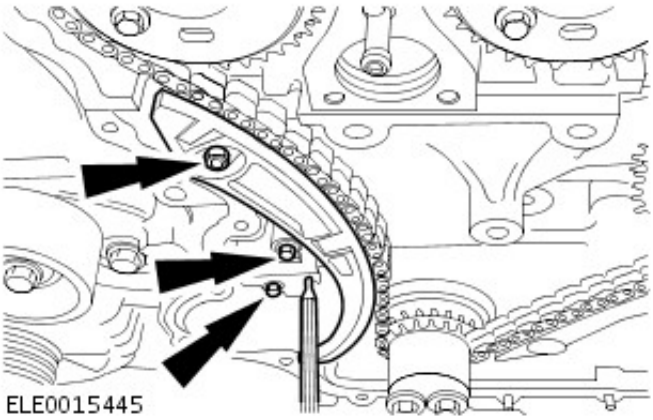
1. Retract the pawl.
2. Push the lock in.
3. Insert a suitable pin.



ELE0015463

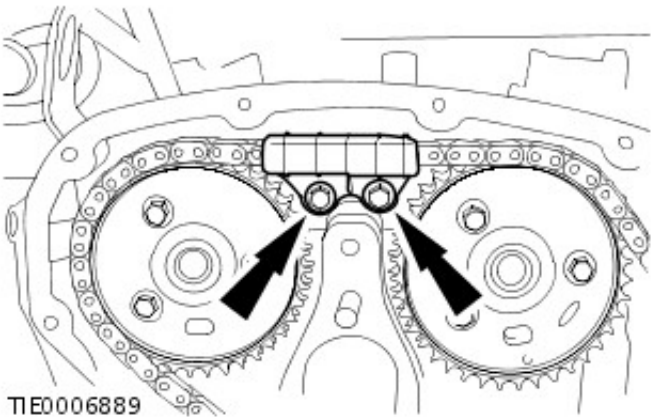
10. Remove the timing chain tensioner and the RH timing chain guide.

- Remove the 2 bolts.
- Remove the nut.

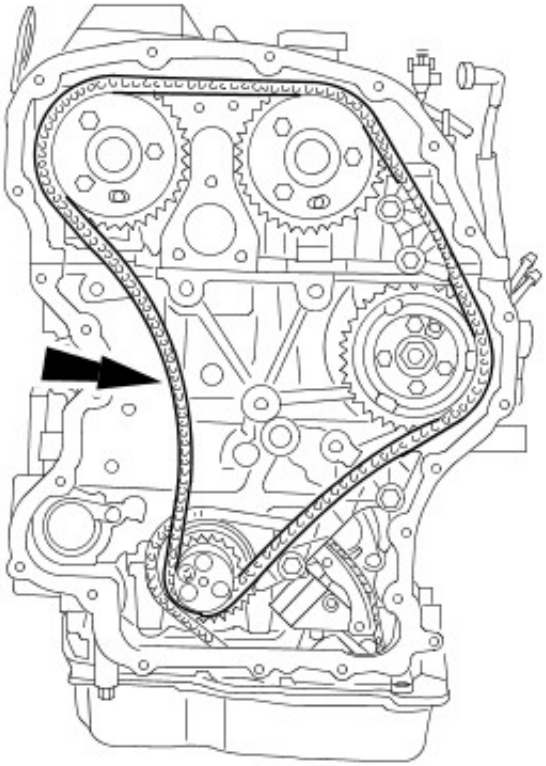

ELE0015445

11. Remove the upper timing chain guide.

- Remove the 2 bolts.

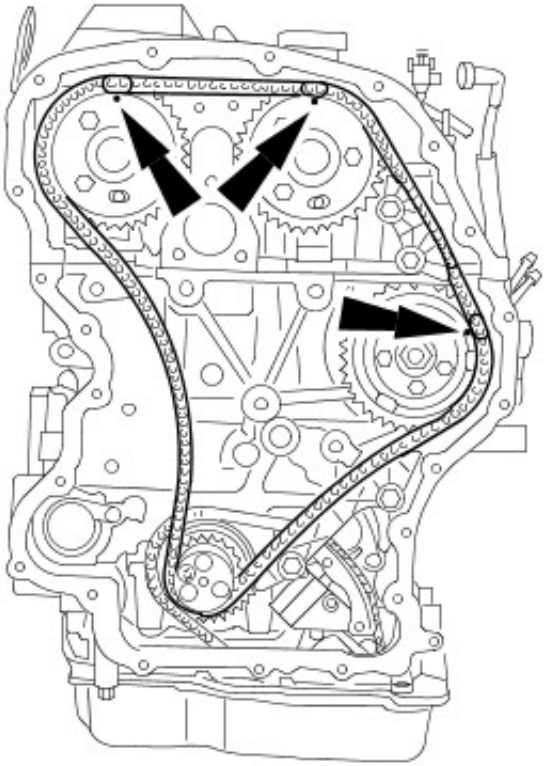

TIE0006889

12. Remove the timing chain.



E46626

Installation



E46627

1. CAUTION: Make sure the colored links align to the timing marks. Failure to follow this instruction may result in damage to the vehicle.

Install the timing chain.

2. CAUTION: Make sure the timing chain tensioner is fully retracted before installation. Failure to follow this instruction may result in damage to the vehicle.

Install the timing chain tensioner and the timing chain guides.

- Tighten the bolts to 15 Nm (11 lb.ft).
- Tighten the nut to 15 Nm (11 lb.ft).

3. NOTE: Make sure the timing chain tensioner is completely released.

Unlock the timing chain tensioner.

- Remove the pin.

4. Secure the camshaft sprockets and the fuel injection pump sprocket.

- Tighten the camshaft sprocket bolts to 35 Nm (24 lb.ft).
- Tighten the fuel injection sprocket bolts to 33 Nm (26 lb.ft).

5. Remove the special tool.

6. Remove the 6 mm bars.

7. Rotate the crankshaft clockwise 2 complete revolutions.

8. CAUTION: Make sure the special tool is fully located in the flywheel.

Check the timing by inserting the special tool in the CKP sensor hole.

9. Check the camshaft timing by inserting a suitable 6 mm bar through the holes in the camshaft sprockets

10. Remove the special tool.

11. Remove the 6 mm bars.

12. Install the CKP sensor.
For additional information, refer to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

13. Install the timing cover.
For additional information, refer to: Timing Cover (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

14. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Valve Cover
In-vehicle Repair

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

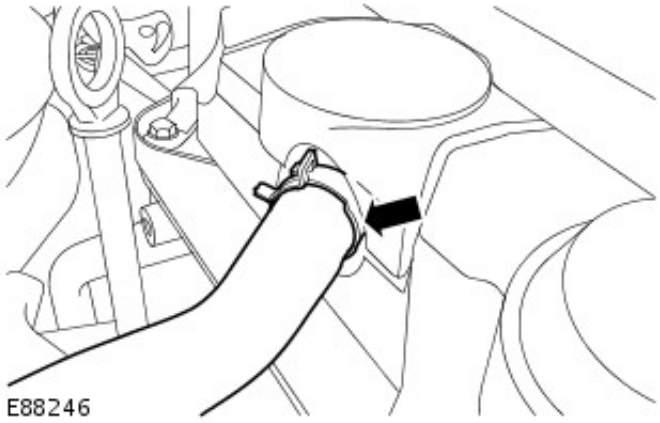
Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

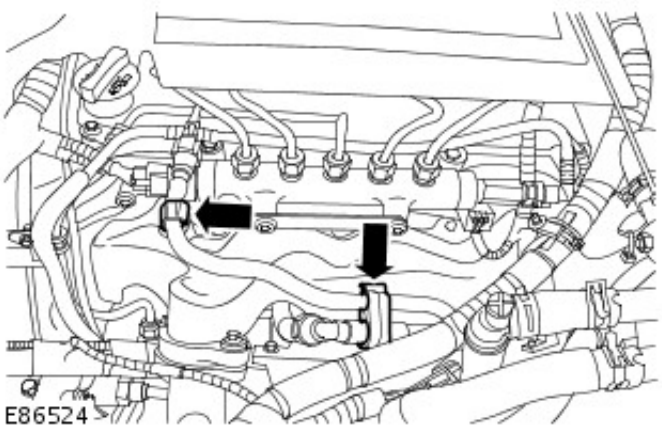
1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Disconnect the positive crankcase ventilation (PCV) hose.



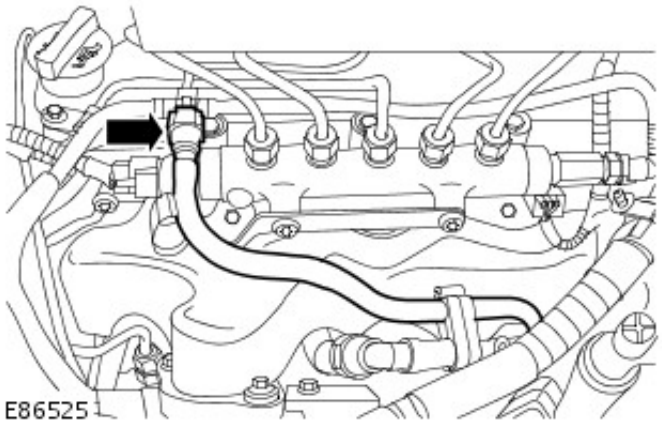
3. Remove the fuel injectors.
For additional information, refer to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

4. Release the fuel line.



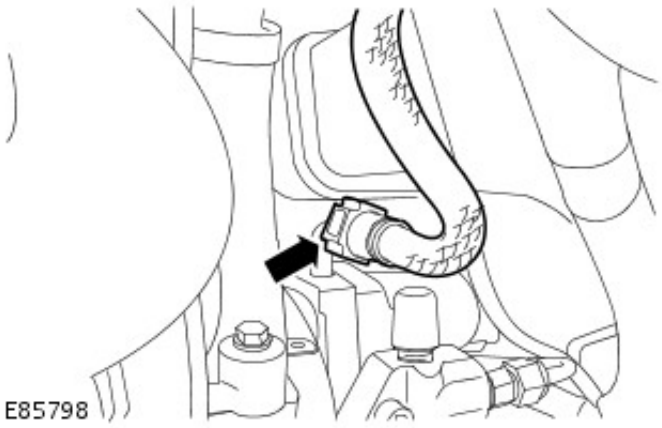
5. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the fuel return line.



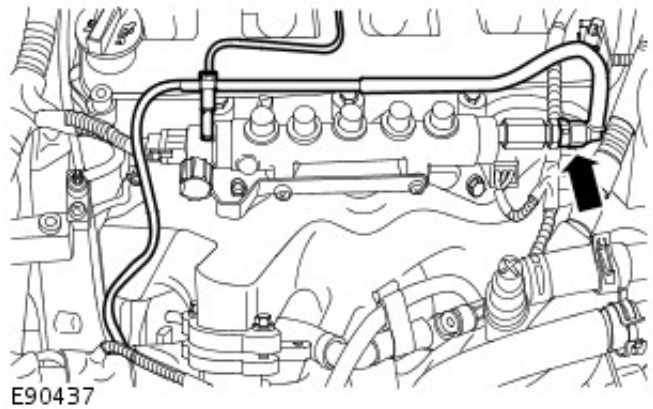
6. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the fuel return line.

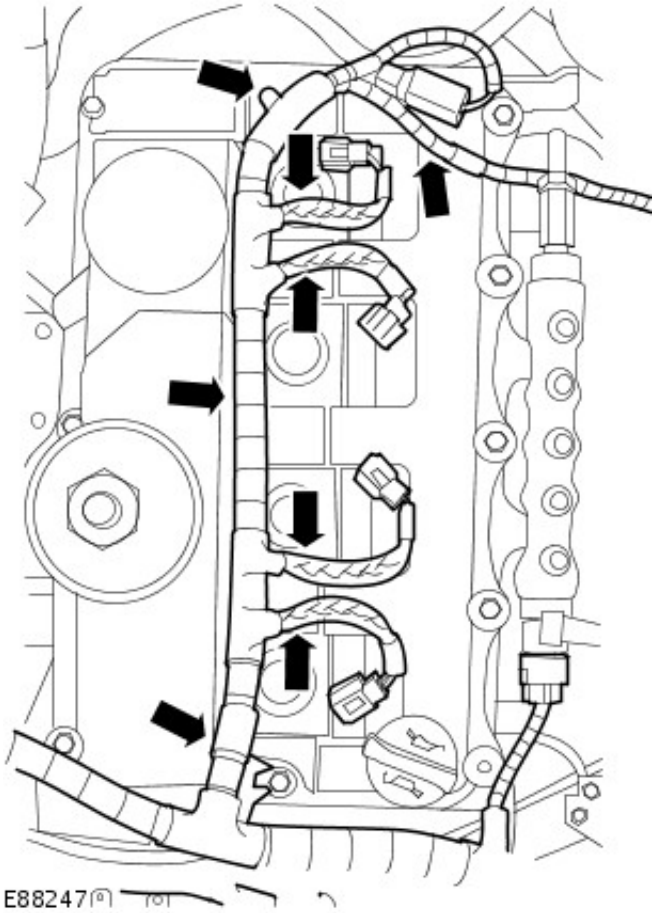


7. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the fuel return line.

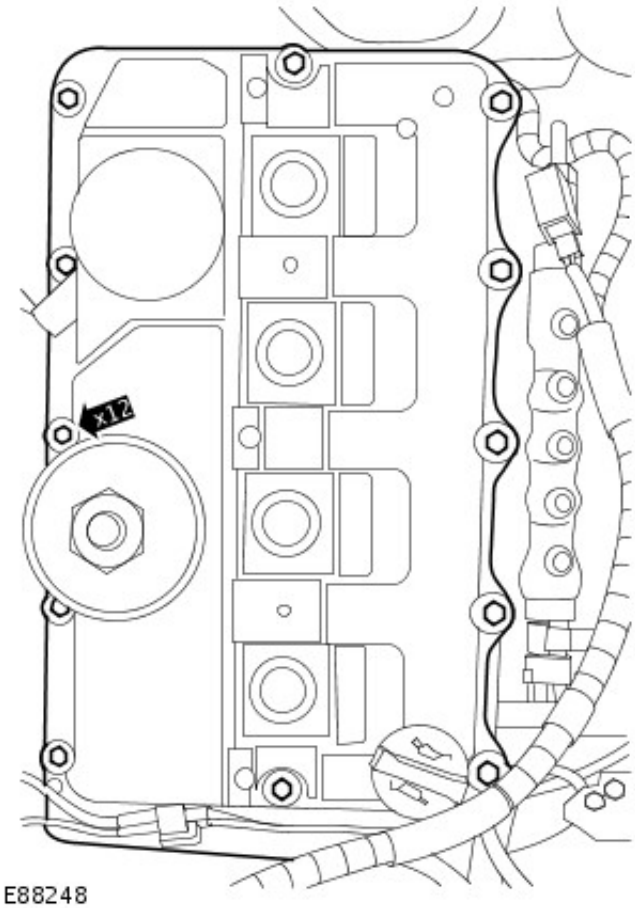


8. Release the engine wiring harness from the valve cover.


E88247

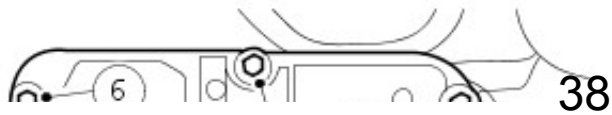
9. Remove the valve cover.

- Fully loosen the 12 bolts.
- Remove and discard the gasket.



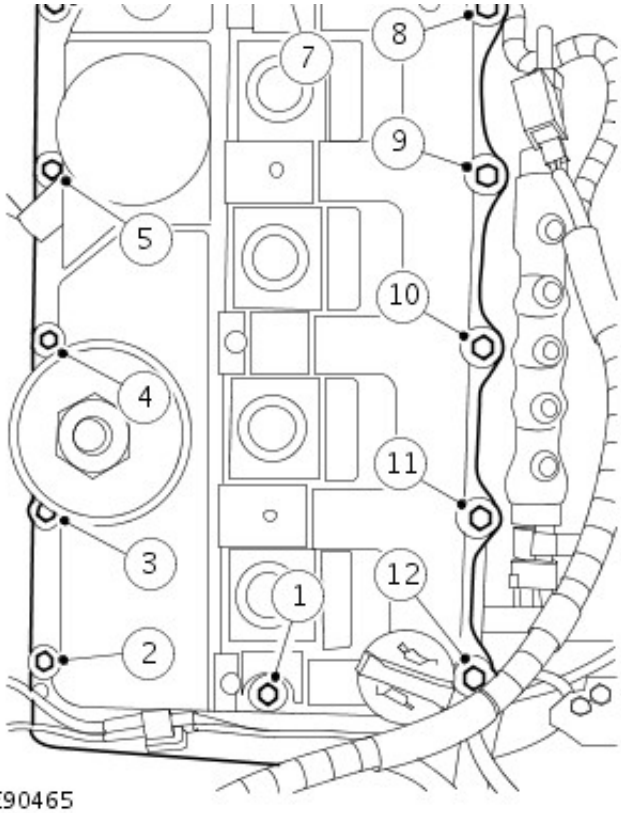
E88248

Installation



1. CAUTION: Tighten the bolts in the sequence shown.

To install, reverse the removal procedure.



E90465

- Install a new gasket.
- Tighten the bolts to 10 Nm (7 lb.ft).

2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine
Removal

Removal

All vehicles

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

3. Remove the Hood.
   For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

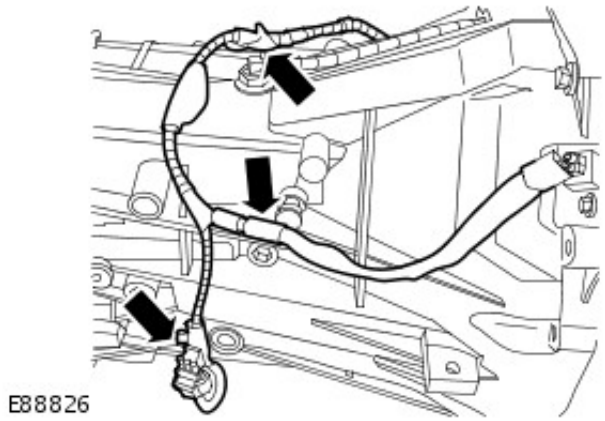
4. Remove the cooling fan shroud.
   For additional information, refer to: Cooling Fan Shroud (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

5. Remove the air cleaner.
   For additional information, refer to: Air Cleaner (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

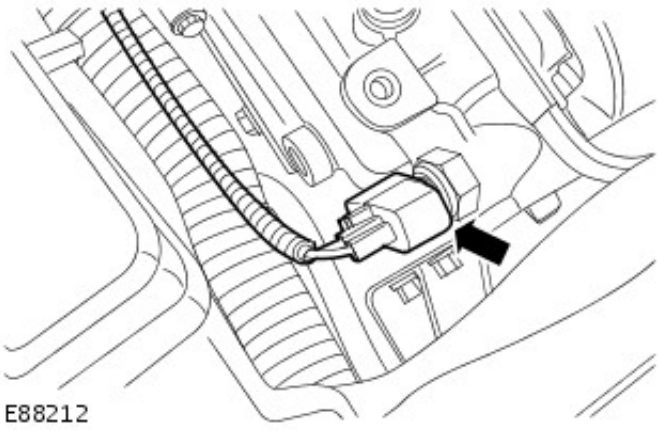
6. Remove the catalytic converter.
   For additional information, refer to: Catalytic Converter (309-00 Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

7. Remove the starter motor.
   For additional information, refer to: Starter Motor (303-06 Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

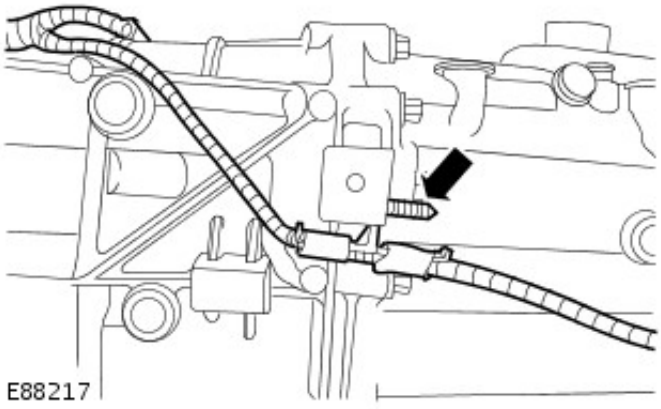
8. Release the crankshaft position (CKP) sensor and reverse light switch wiring harness from the transmission.
   - Release the 3 clips.


E88826

9. Disconnect the reverse light switch electrical connector.


E88212

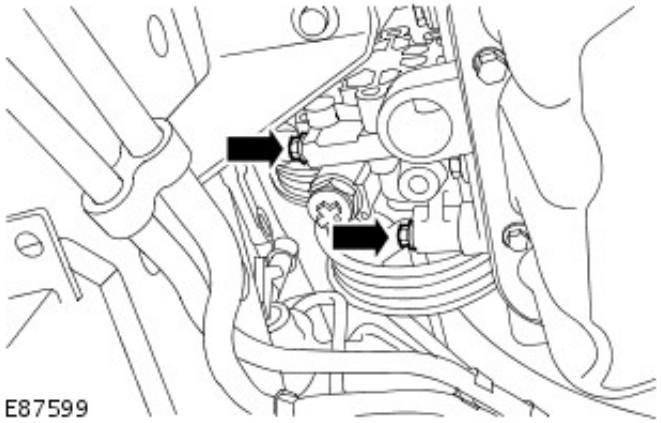
10. Release the reverse light switch wiring harness from the



transmission.

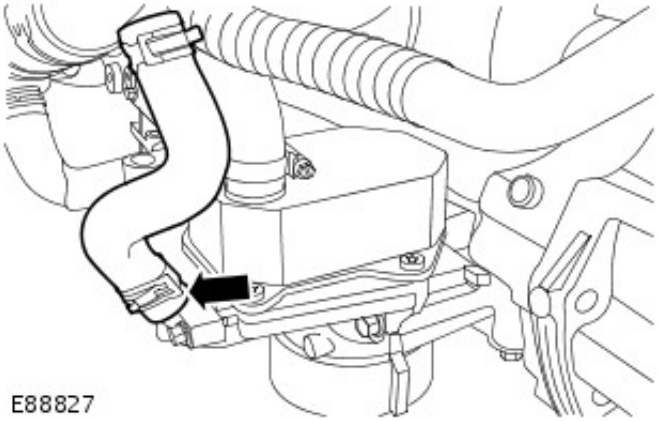
- Release the clip.

11. Fully loosen the power steering pump lower 2 bolts.



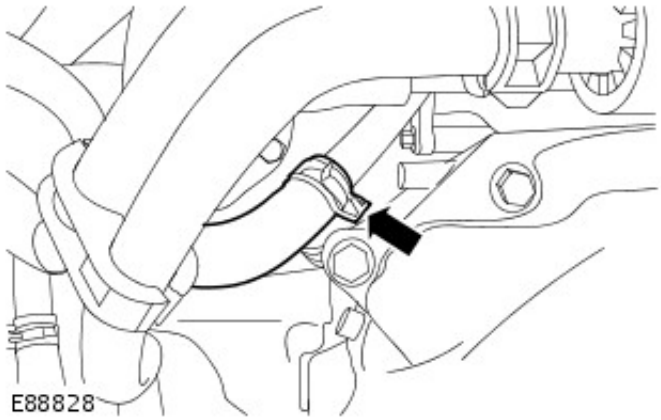
12. Disconnect the coolant hose from the engine oil cooler.

- Release the clip.



13. Disconnect the exhaust gas recirculation (EGR) cooler coolant hose.

- Release the clip.



Vehicles with air conditioning

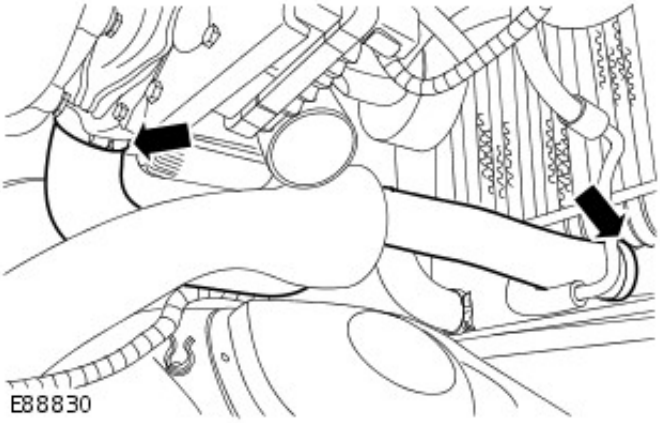
14. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the air conditioning (A/C) high-pressure

refrigerant line.

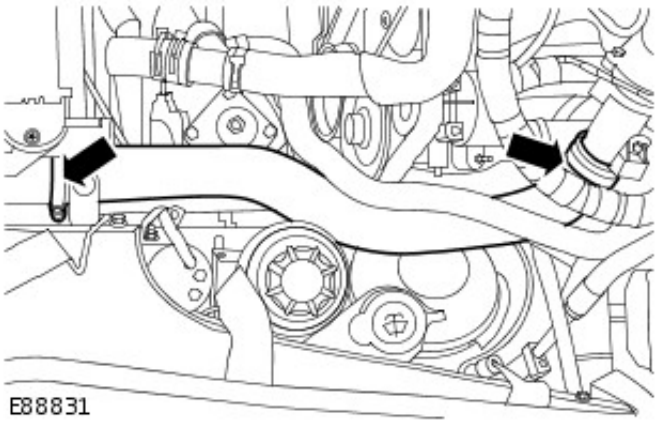
- Remove and discard the 2 O-ring seals.

All vehicles



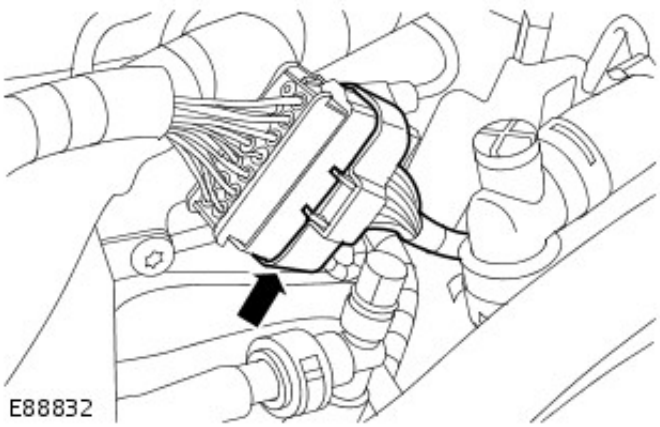
15. Remove the charge air cooler inlet hose.

- Loosen the 2 clips.



16. Remove the charge air cooler outlet hose.

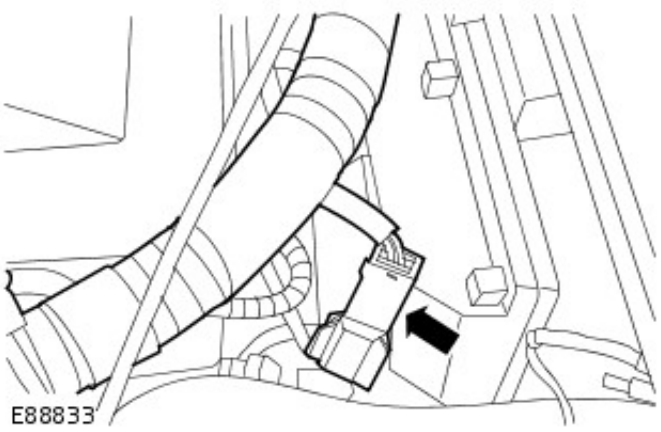
- Loosen the 2 clips.



17. Disconnect the engine wiring harness electrical connector.

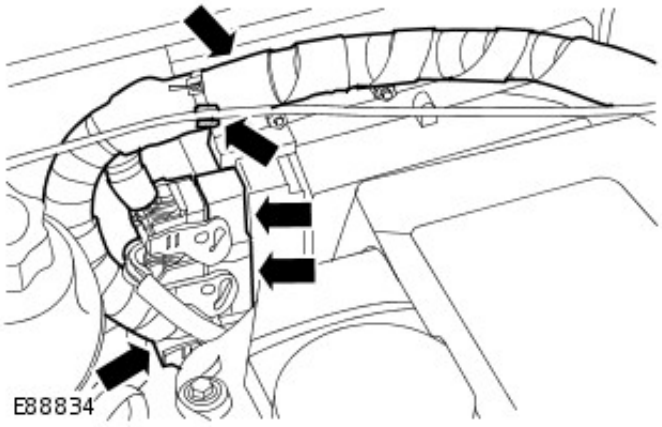
18. Disconnect the glow plug electrical connector.

18. Disconnect the glow plug electrical connector.

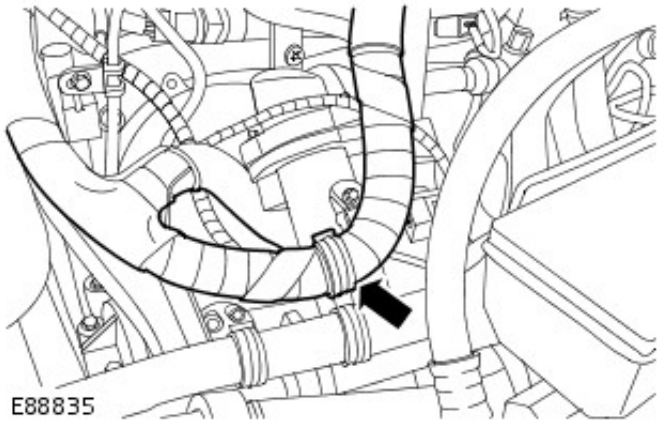


19. Release the engine wiring harness.

- Disconnect the 3 electrical connectors from the engine control module (ECM) .
- Release from the 2 clips.

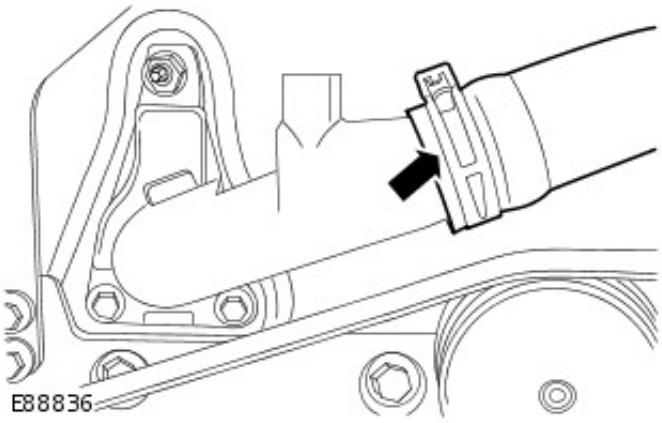


20. Release the wiring harness from the heater coolant hose.

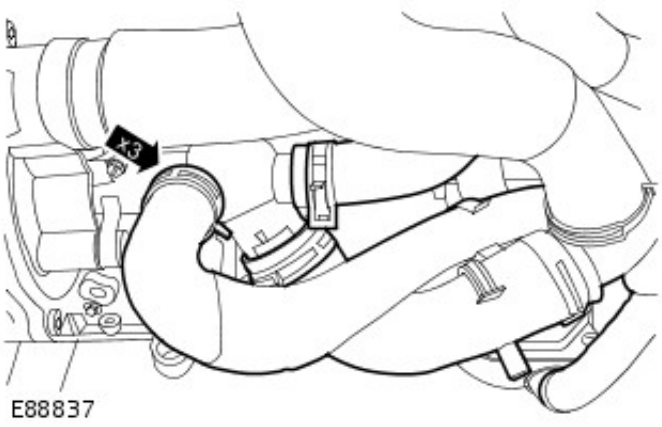


21. Disconnect the radiator upper coolant hose.

- Release the clip.

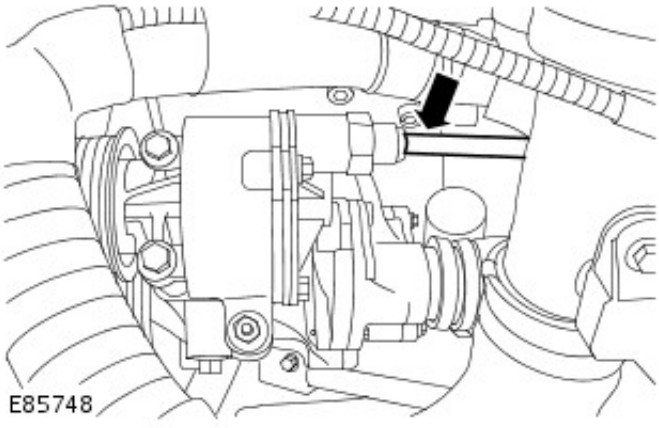


22. Disconnect the 3 coolant hoses from the coolant pump

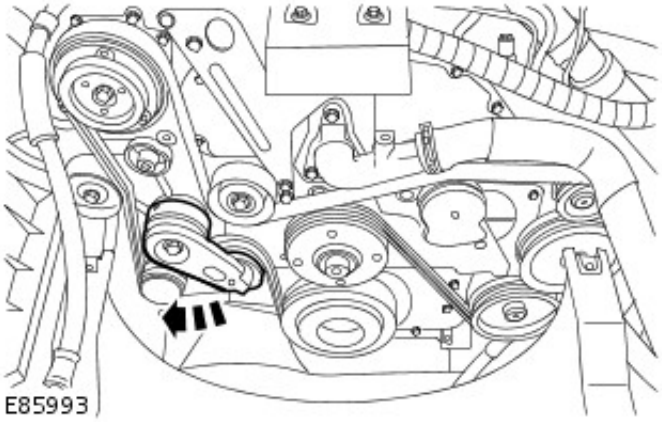


housing.

- Release the 3 clips.

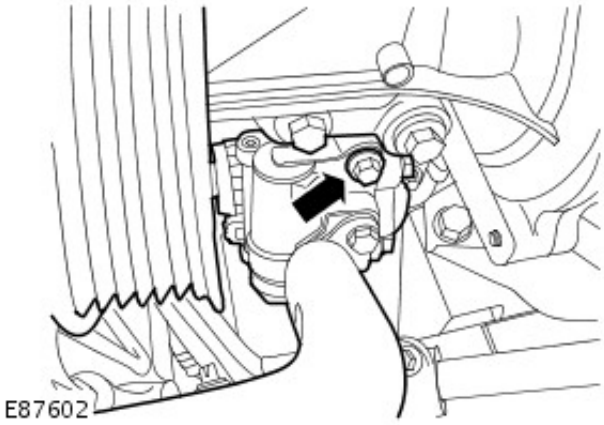


23. Disconnect the brake booster vacuum line from the brake vacuum pump.



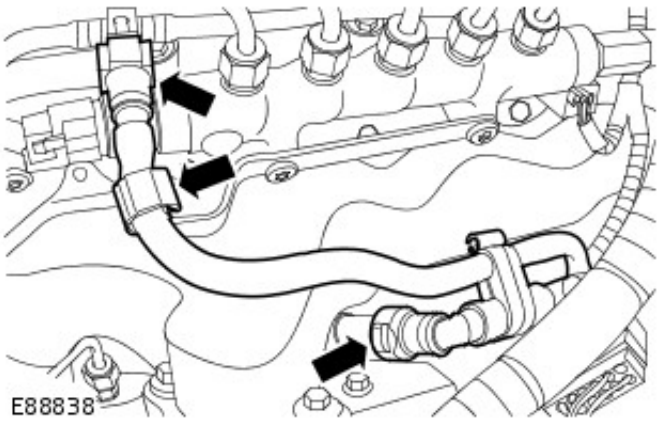
24. Release the accessory drive belt from the power steering pump pulley.

- Release the tension from the belt.



25. Release the power steering pump.

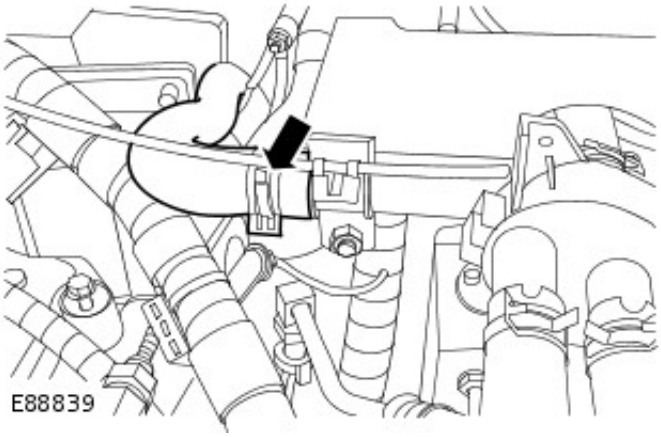
- Remove the remaining bolt.
- Tie the power steering pump aside.



26. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

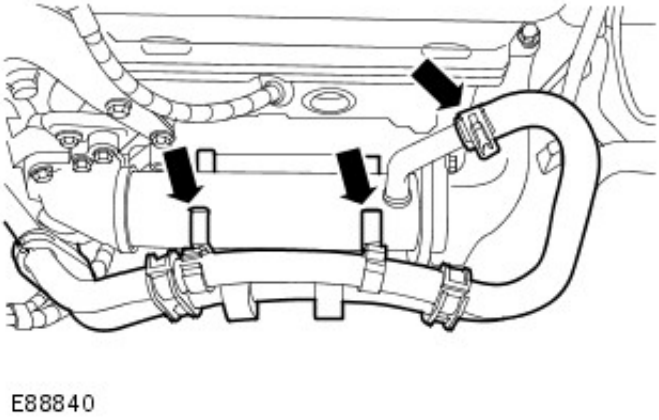
Disconnect the 2 fuel lines.

- Release the fuel return line from the clip.



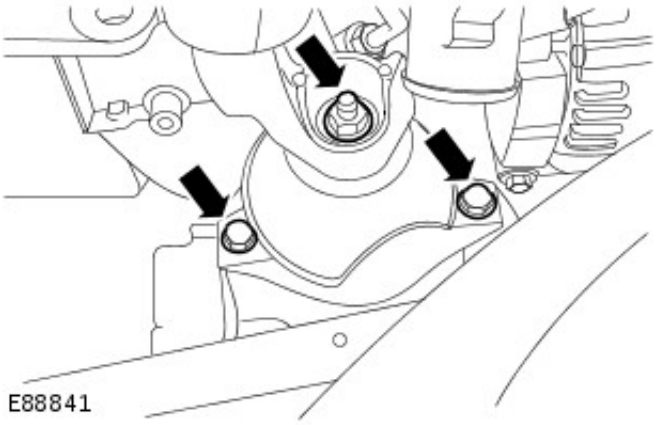
27. Disconnect the heater coolant hose from the heater control valve.

- Release the clip.



28. Disconnect the EGR cooler coolant hose.

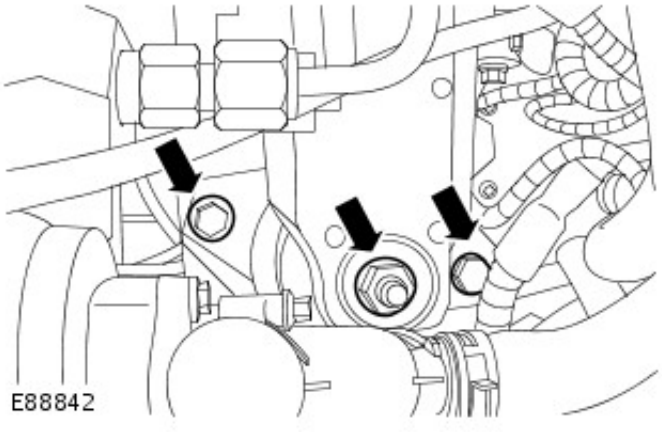
- Release the clip.
- Release the coolant hoses from the EGR cooler.



29. Release the RH engine mount.

- Remove the nut.
- Remove the 2 bolts.

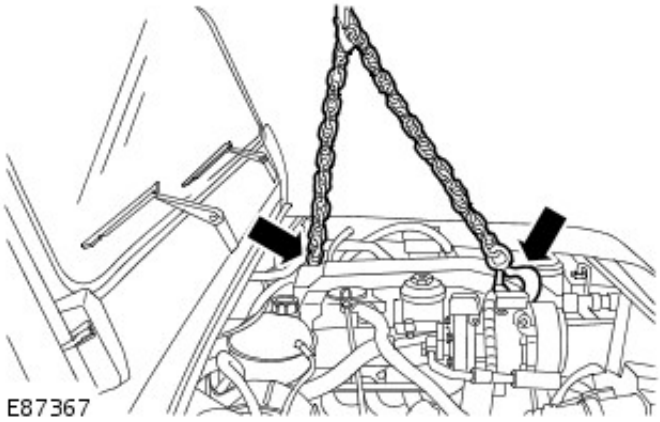
30. Release the LH engine mount.



- Remove the nut.
- Remove the 2 bolts.

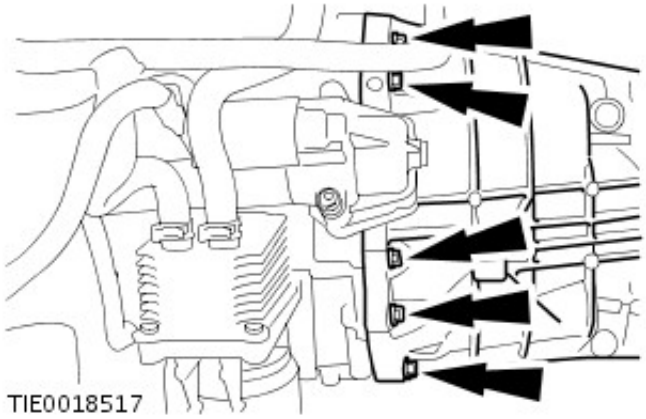
31. Raise and support the engine.

- Using a suitable hydraulic jack, support the transmission.

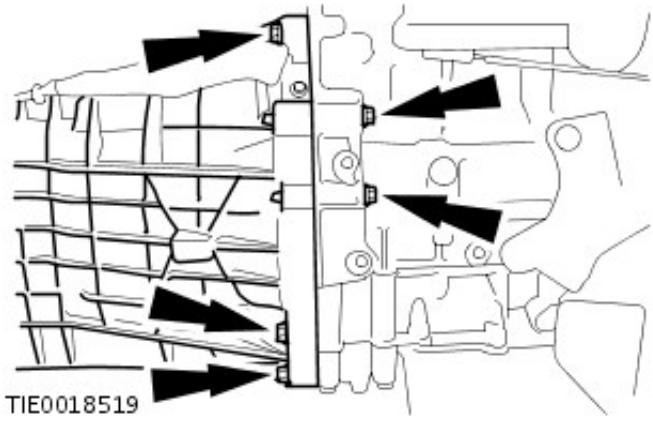


32. Remove both of the engine mounts.

33. Remove the 5 LH engine to transmission bolts.

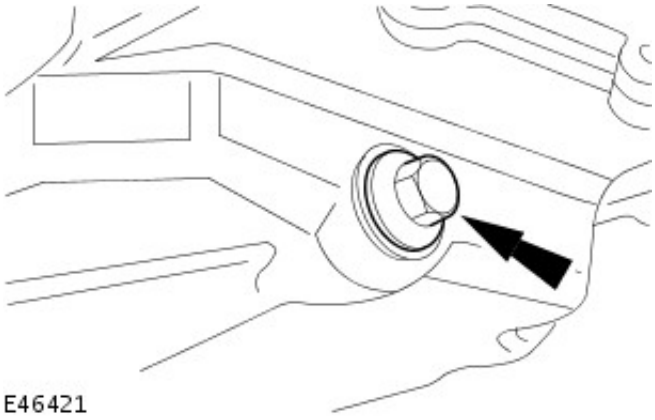


34. Remove the 5 RH engine to transmission bolts.



35. With assistance, carefully remove the engine.

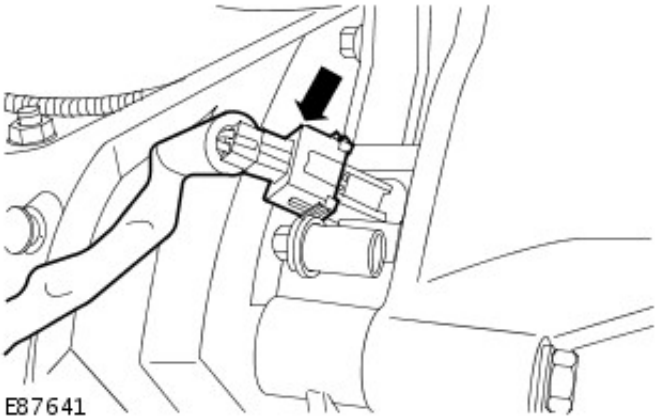
Disassembly


E46421

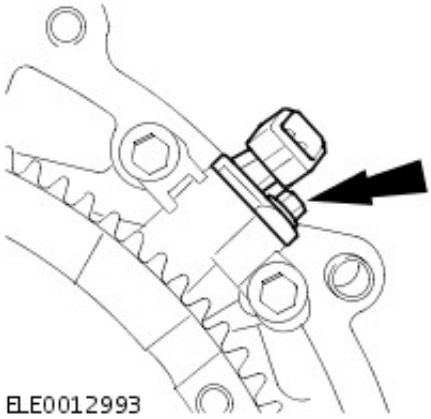
1. Install the engine to suitable engine stand.

2. Drain the engine oil.

- Position a container to collect the engine oil.
- Remove the drain plug.
- Allow the engine oil to drain.

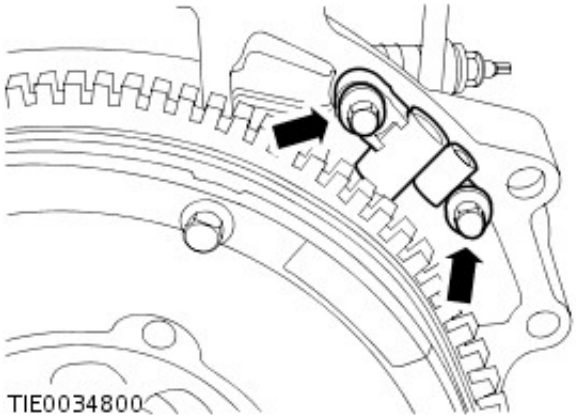

E87641

3. Disconnect the crankshaft position (CKP) sensor electrical connector.


ELE0012993

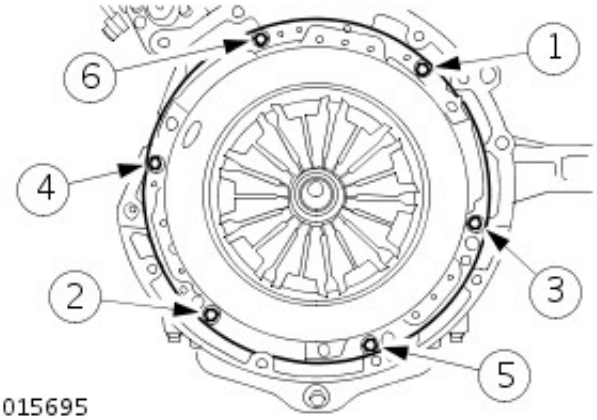
4. Remove the CKP sensor.

- Remove the bolt.


TIE0034800

5. Remove the CKP sensor bracket.

- Remove the 2 bolts.

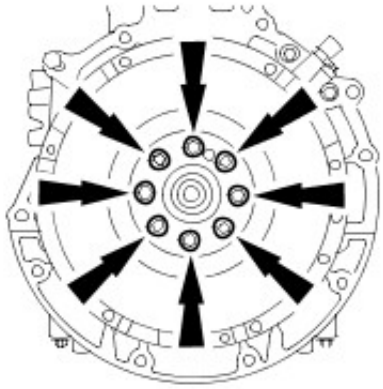


ELE0015695

6. CAUTION: Loosen the clutch pressure plate bolts by 2 turns at a time in the sequence shown.

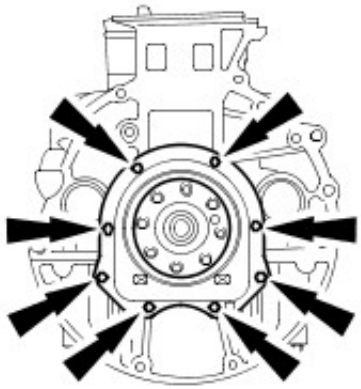
Remove the clutch disc and the clutch pressure plate.

- Remove the 6 bolts.


TIE0012992

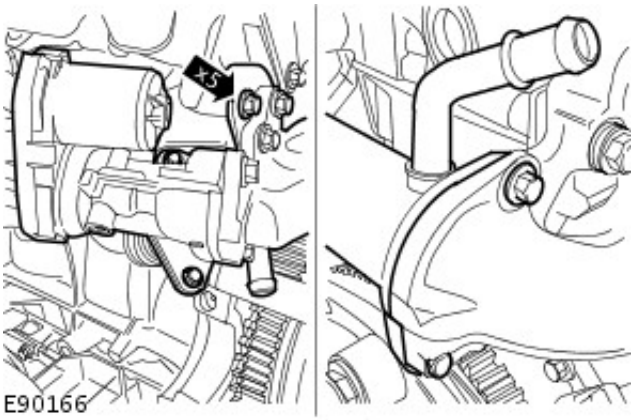
7. Remove the flywheel.

- Remove and discard the 8 bolts.


TIE0012994

8. Remove and discard the crankshaft rear seal.

- Remove the 8 bolts.



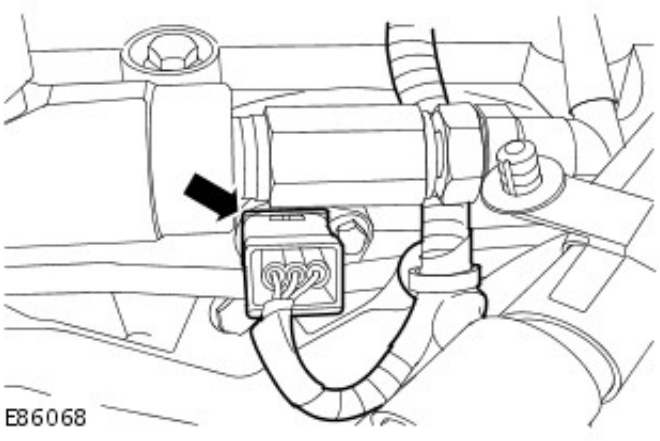
E90166

9. Remove the exhaust gas recirculation (EGR) valve and the EGR cooler.

- Disconnect the EGR valve electrical connector.
- Remove the 5 bolts.
- Discard the 2 gaskets.

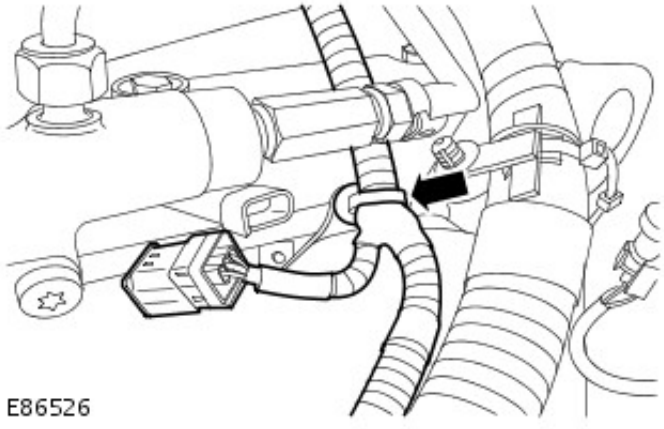
10. Disconnect the camshaft position (CMP) sensor electrical

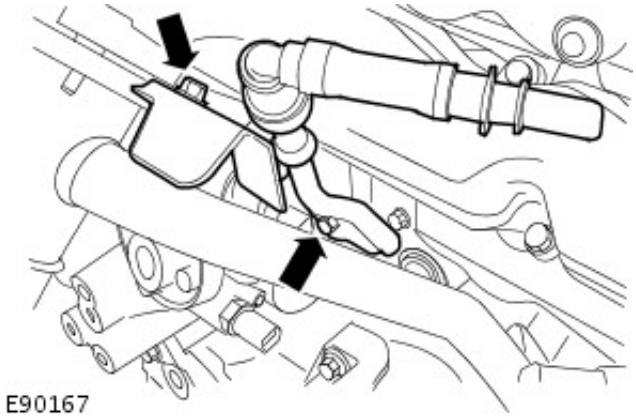
connector.



11. Release the engine wiring harness.

- Release the clip.

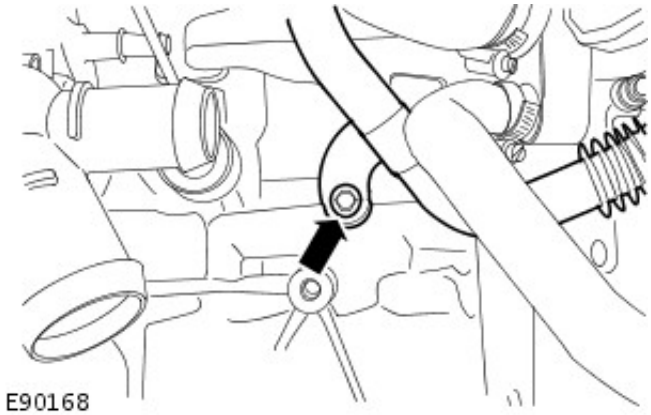




12. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the fuel injection pump supply pipe.

- Remove the bolt.



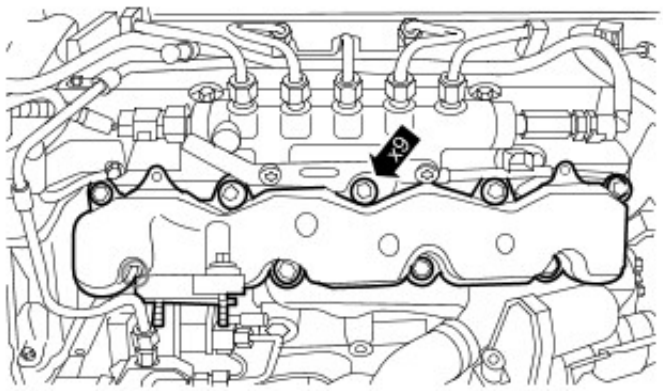
13. Release the EGR valve outlet tube.

- Remove the bolt.

14. Remove the EGR valve outlet tube and intake manifold

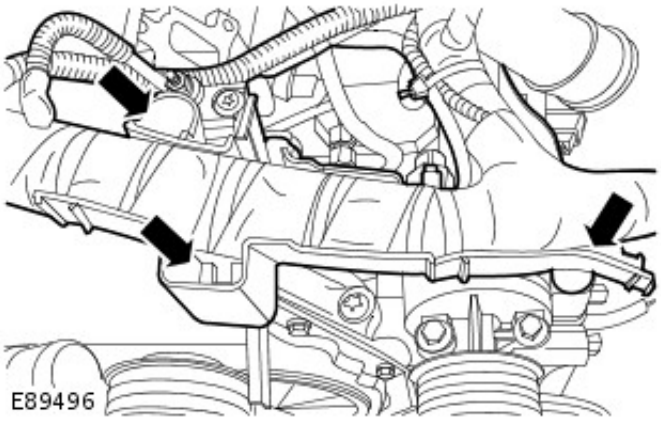
14. Remove the EGR valve outlet tube and intake manifold assembly.

- Fully loosen the 9 bolts.
- Remove and discard the 8 seals.

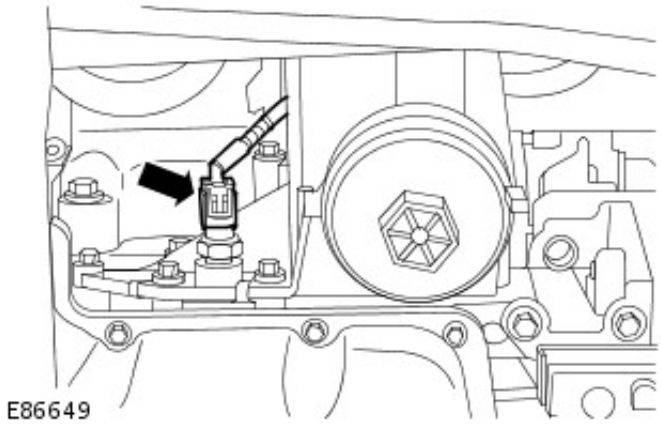

E86529

15. Release the engine wiring harness.

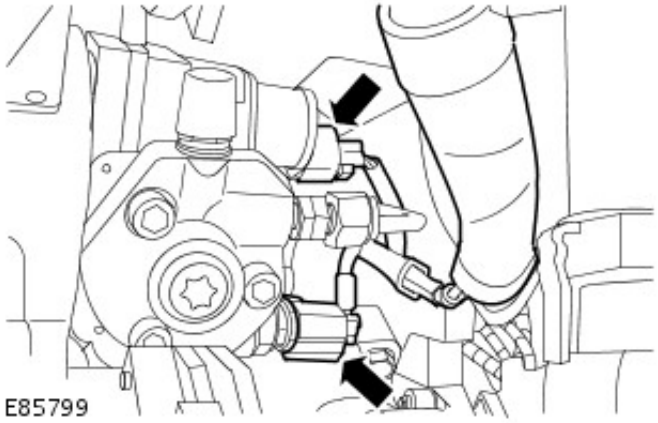
- Release the 3 clips.


E89496

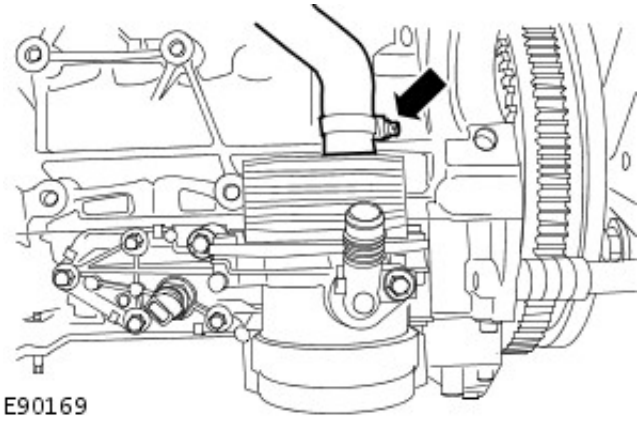
16. Disconnect the engine oil pressure (EOP) sensor electrical connector.


E86649

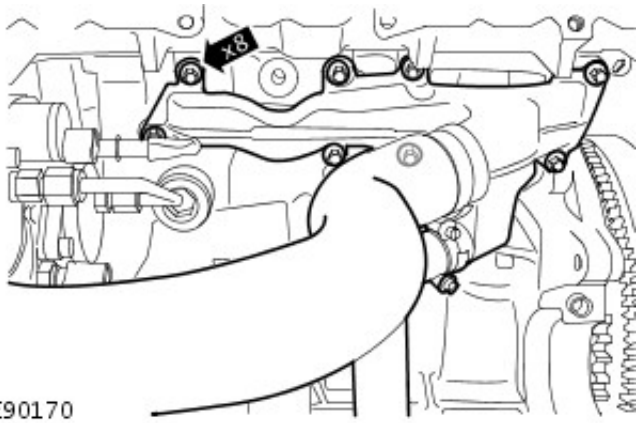
17. Disconnect the fuel metering valve and the fuel temperature sensor electrical connectors.


E85799

18. Disconnect the coolant hose.


E90169

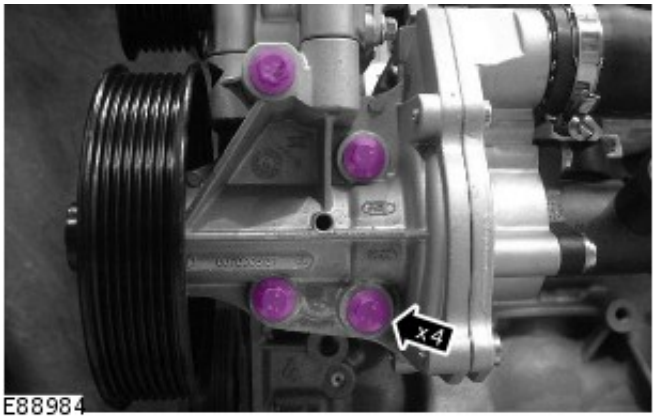
- Release the clip.



E90170

19. Release the coolant manifold.

- Remove the 8 bolts.
- Remove and discard the gasket.



E88984

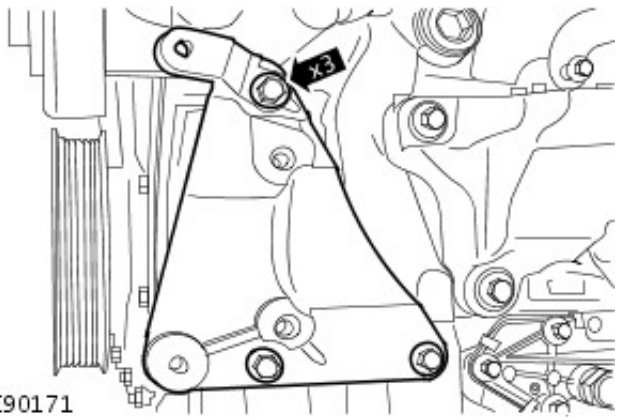
20. Release the coolant pump.

- Remove the 4 bolts.
- Remove and discard the gasket.

21. Remove the coolant pump and coolant manifold assembly.

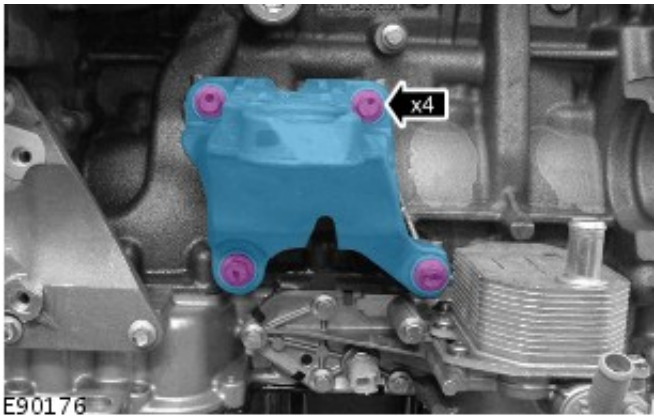
22. Remove the power steering pump bracket.

- Remove the 3 bolts.

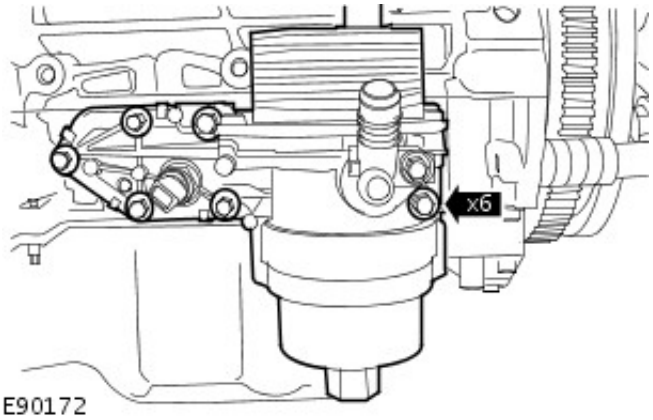


E90171

23. Remove the LH engine mount bracket.



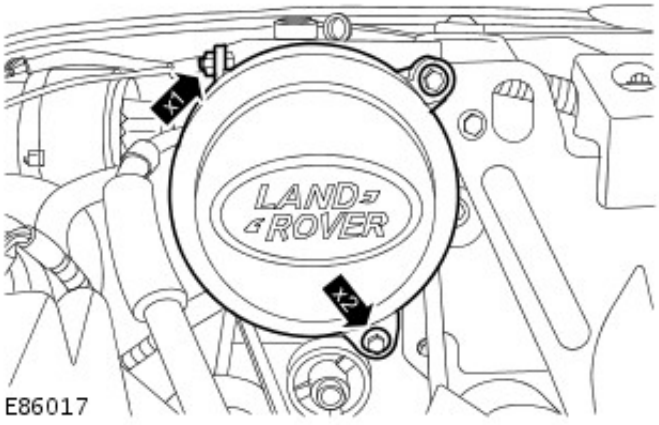
- Remove the 4 bolts.



24. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

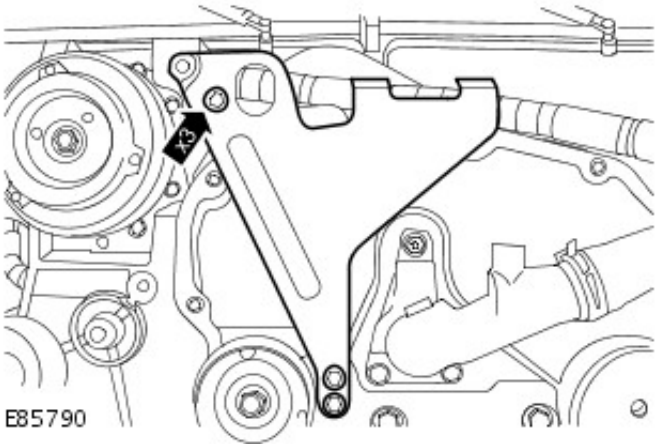
Remove the oil filter housing assembly.

- Remove the 6 bolts.
- Remove and discard the gasket.



25. Remove the air conditioning (A/C) compressor pulley cover.

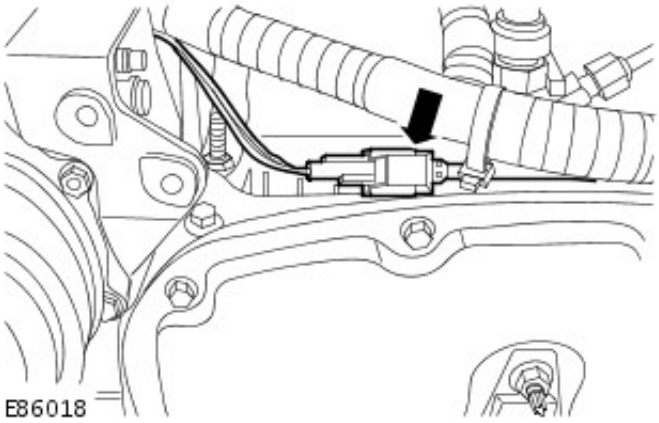
- Remove the 2 bolts.
- Remove the nut.
- Remove the accessory drive belt.



26. Remove the engine lifting bracket.

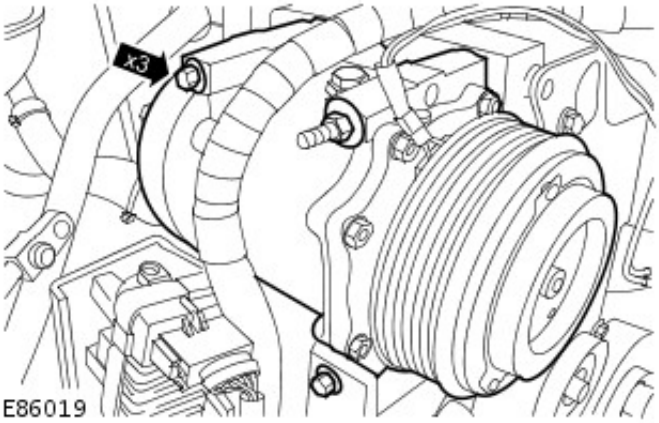
- Remove the 3 bolts.

27. Disconnect the A/C compressor electrical connector.



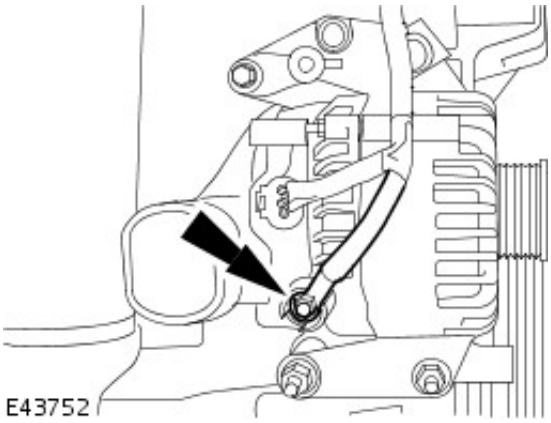
28. Remove the A/C compressor.

- Remove the 3 bolts.

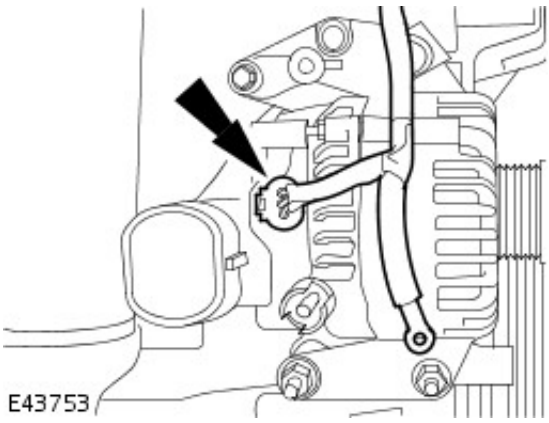


29. Disconnect the battery positive cable from the generator.

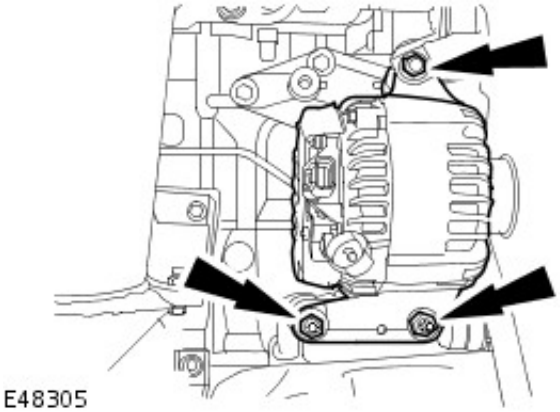
- Remove the nut.



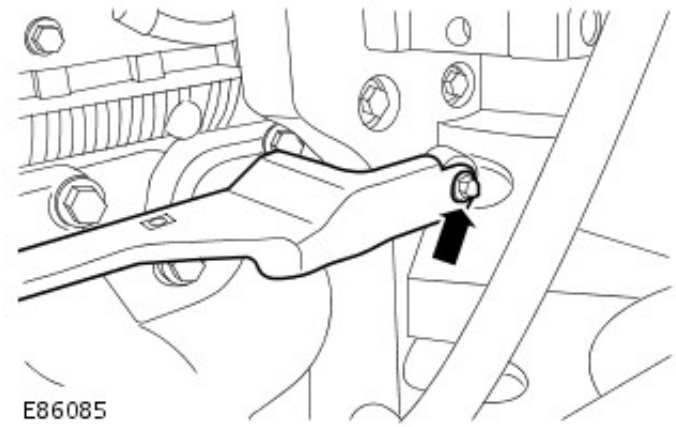
30. Disconnect the generator electrical connector.



31. Remove the generator.

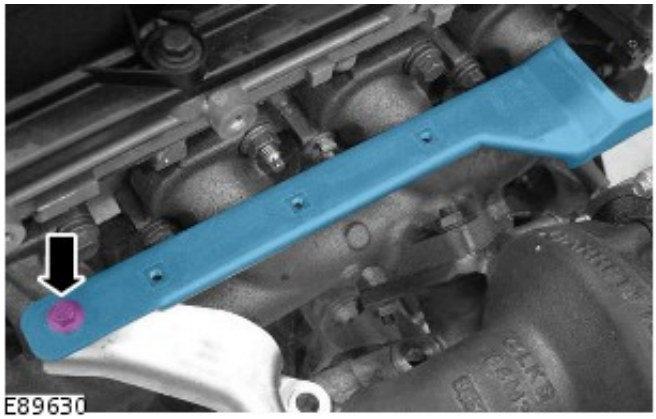


- Remove the 3 bolts.



32. Release the turbocharger heat shield bracket.

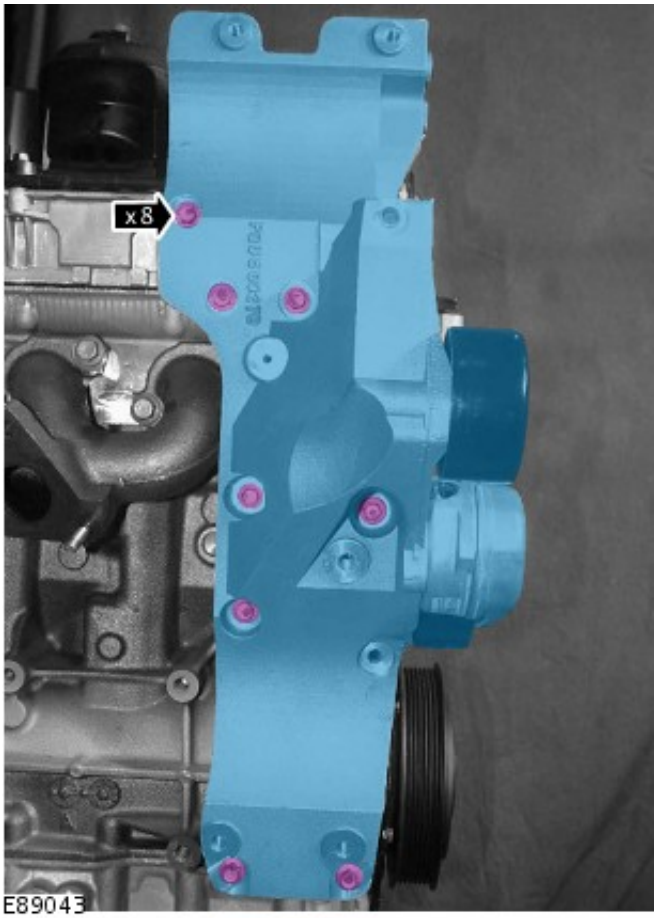
- Remove the bolt.



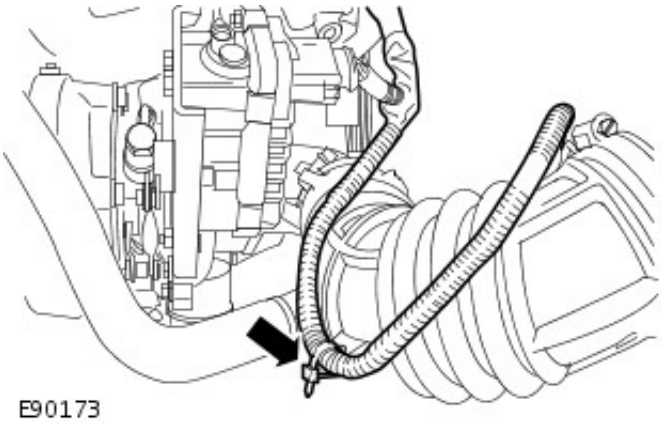
33. Remove the turbocharger heat shield bracket.

- Remove the bolt.

34. Remove the generator mounting bracket.

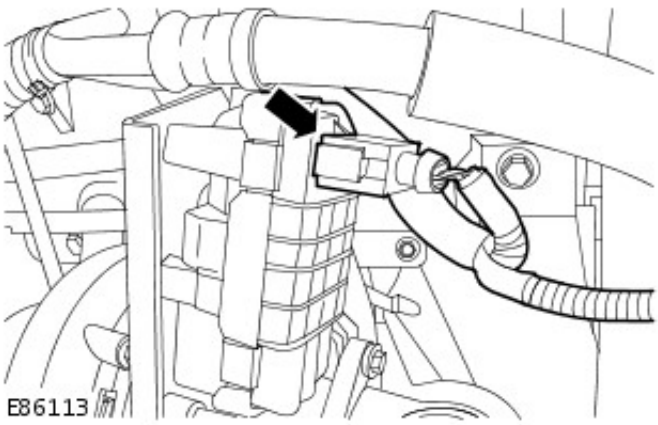


- Remove the 8 bolts.



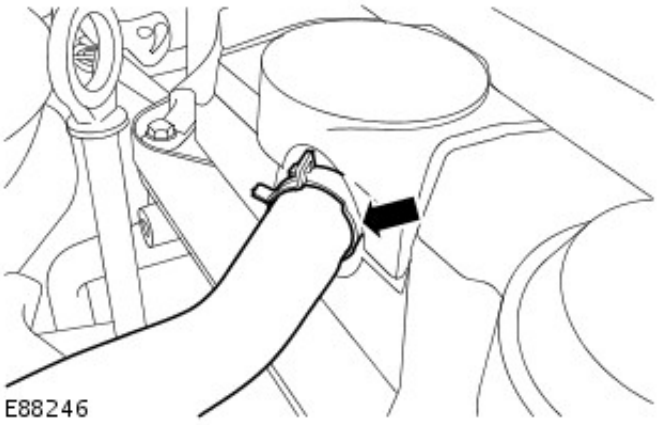
35. Release the mass air flow (MAF) sensor wiring harness.

- Cut the tie strap.

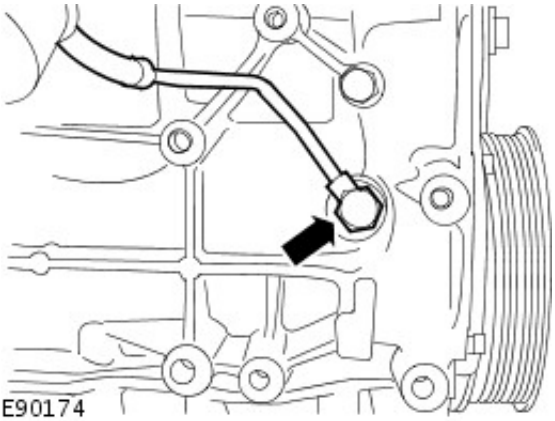


36. Disconnect the turbocharger actuator electrical connector.

37. Disconnect the breather pipe.



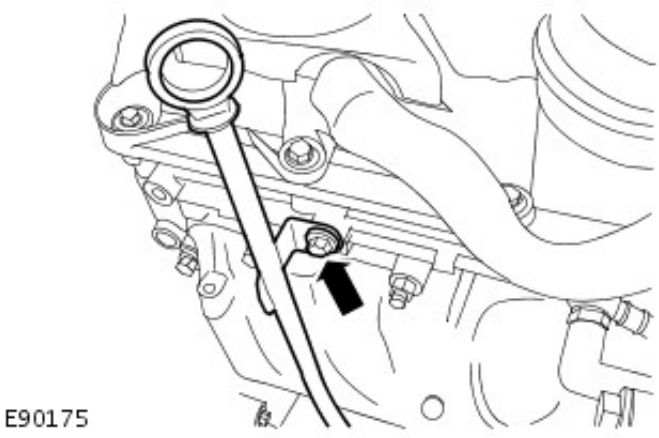
- Release the clip.



38. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the turbocharger oil feed pipe.

- Remove the banjo bolt.
- Remove and discard the sealing washers.



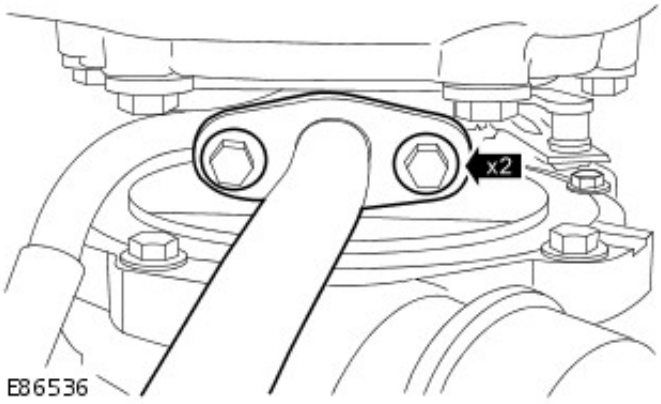
39. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the oil level indicator and the oil level indicator tube.

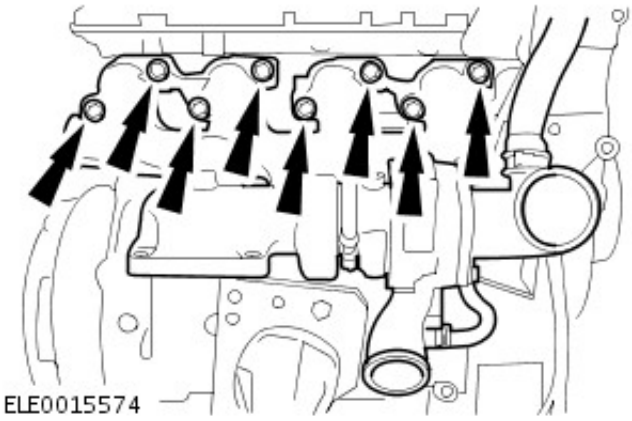
- Remove the bolt.
- Release the wiring harness.
- Remove and discard the O-ring seal.

40. Release the turbocharger oil return pipe.

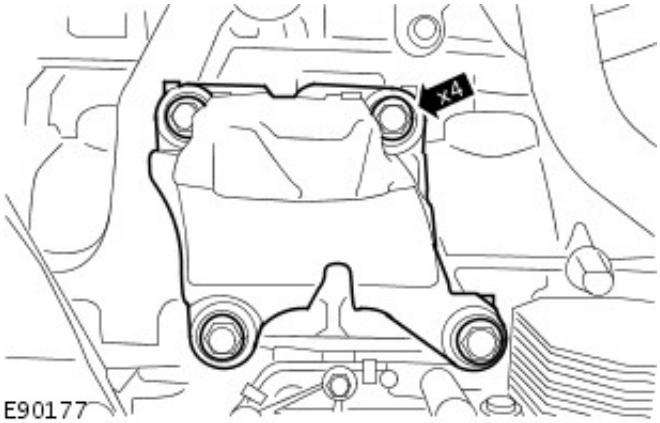
- Remove the 2 bolts.
- Remove and discard the gasket.



41. Remove the exhaust manifold and turbocharger assembly

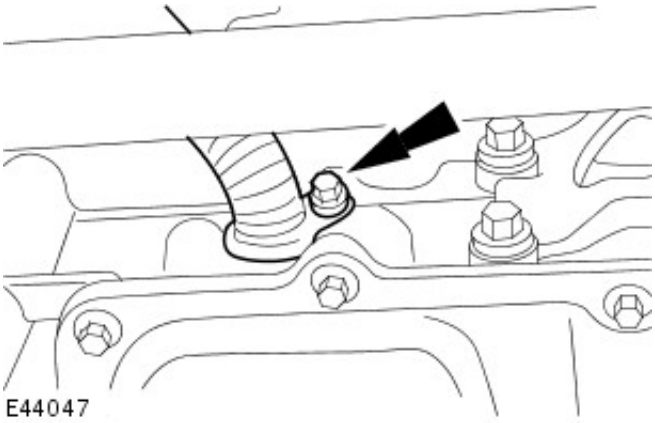


- Remove and discard the 2 nuts.
- Remove the 6 bolts.
- Remove and discard the gasket.



42. Remove the RH engine mount bracket.

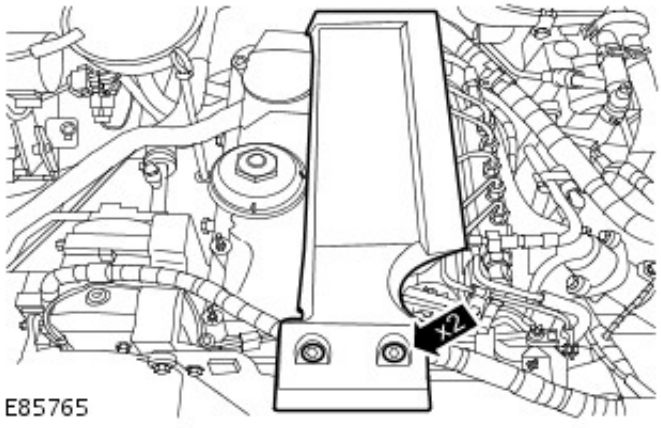
- Remove the 4 bolts.



43. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the turbocharger oil return tube.

- Remove the bolt.
- Remove the clamp.
- Remove and discard the O-ring seal.

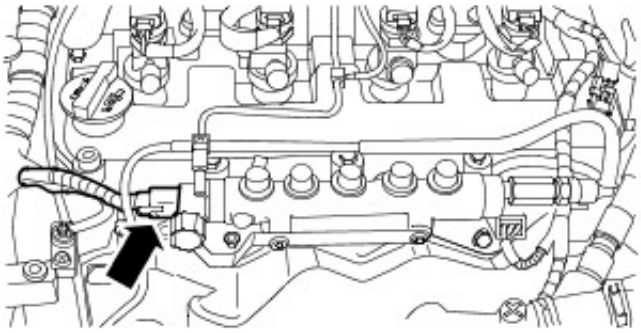


44. Remove the engine cover.

- Remove the 2 bolts.

45. Disconnect the fuel rail pressure sensor (FRP) electrical

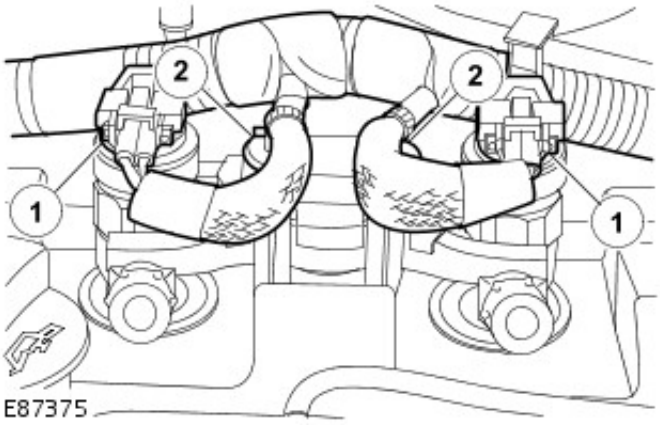
connector.



E90178

46. Disconnect the 4 injectors electrical connectors.

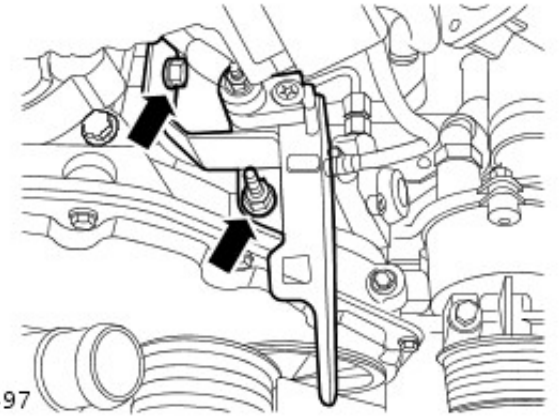
- Release the injector wiring harness.
- Release the 7 clips.



E87375

47. Release the engine wiring harness support bracket.

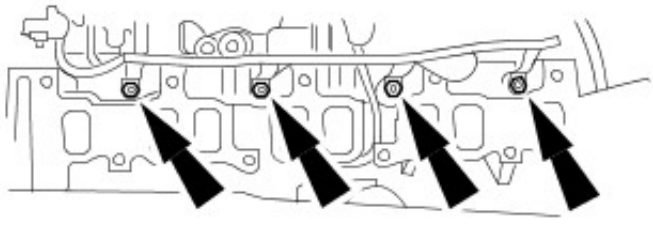
- Remove the nut.
- Remove the bolt.



E89497

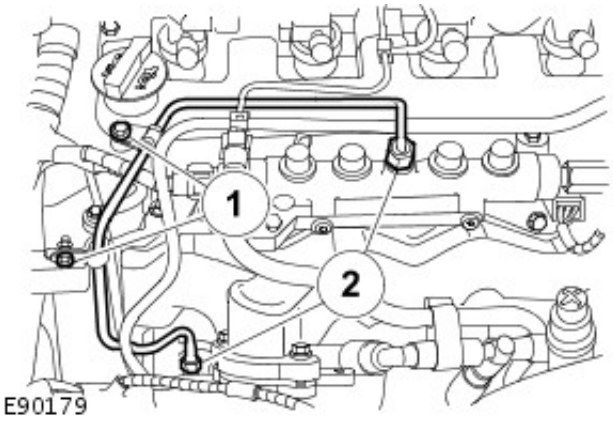
48. Release the glow plug wiring harness.

- Remove the 4 nuts.



E89632

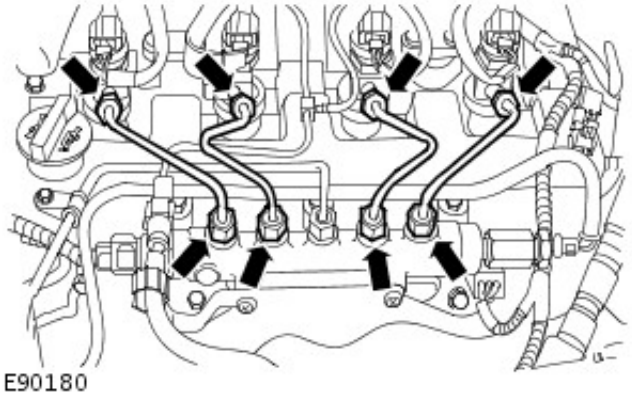
49. Remove the engine wiring harness.



50. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

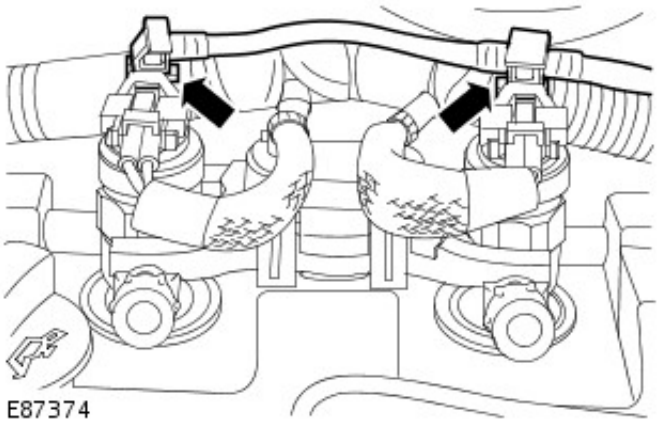
Remove and discard the high-pressure fuel rail supply line.

- Release the 2 clips.



51. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

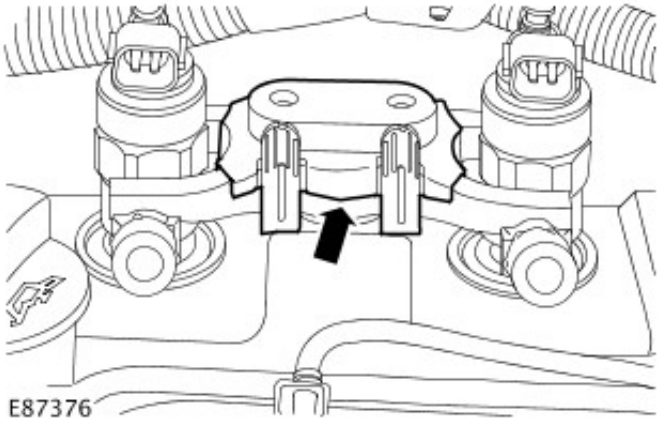
Remove and discard the 4 high-pressure injector supply lines.



52. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

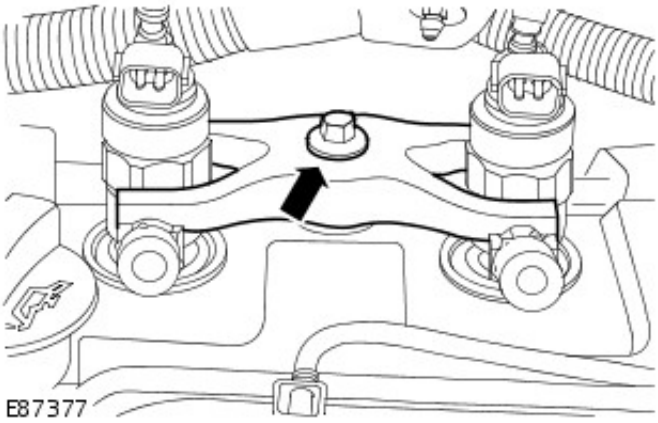
Disconnect the injector spill rail.

- Remove the 4 clips.



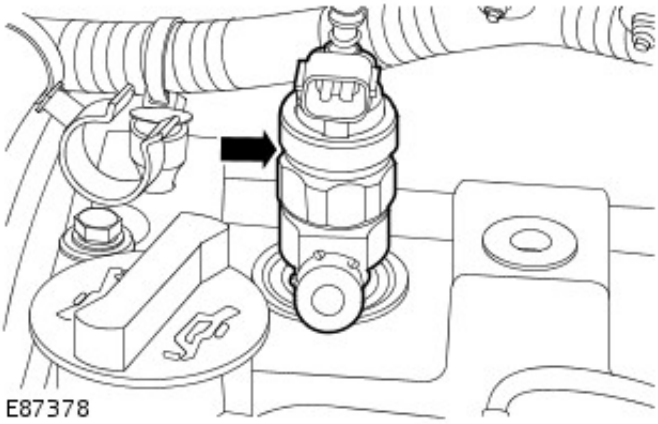
53. Remove the 2 injector clamp covers.

54. Remove the 2 injector clamps



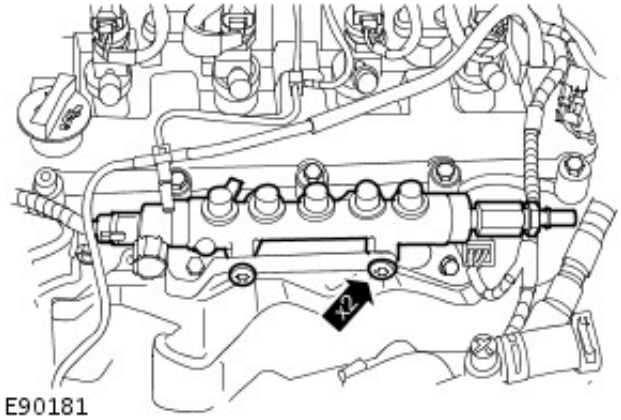
- Remove the 2 bolts.

55. Remove the 4 injectors.



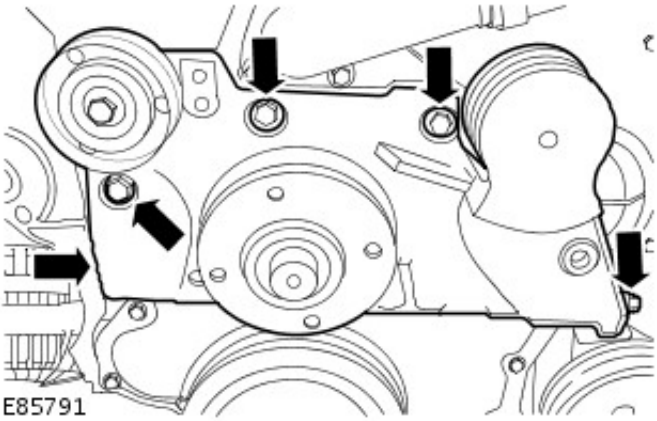
- Remove and discard the sealing washer.

56. Remove the fuel rail.



- Remove the 2 bolts.
- Remove the bracket.

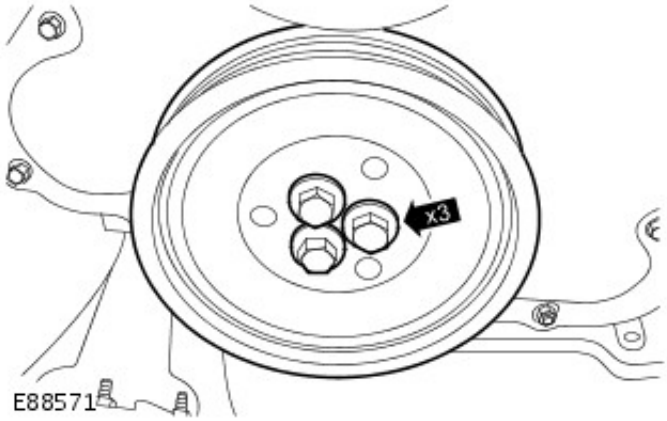
57. Remove the accessory drive belt idler assembly.



- Remove the 5 bolts.

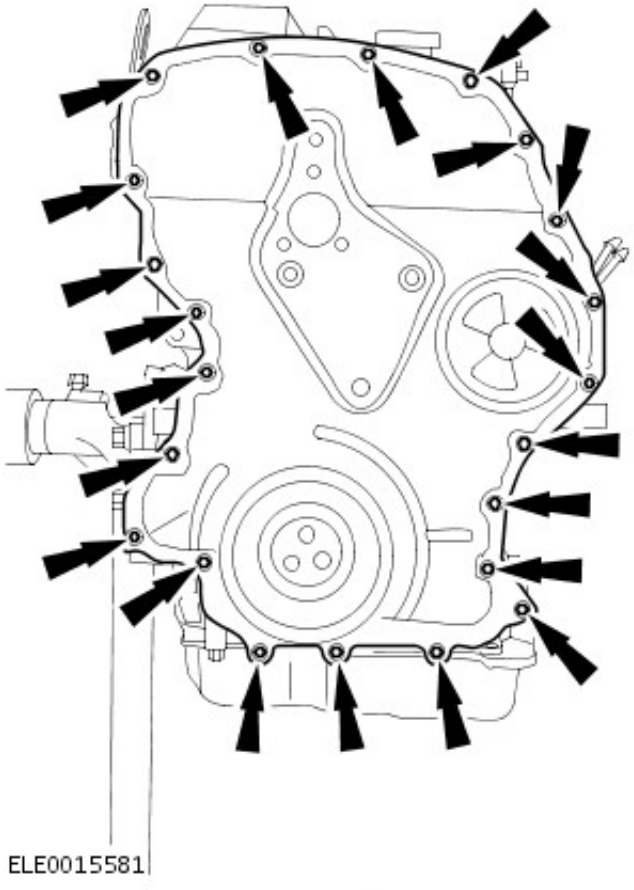
58. Remove the cylinder head coolant outlet elbow.

- Remove the nut.
- Remove the 2 bolts.
- Remove and discard the O-ring seal.



59. Remove the crankshaft pulley.

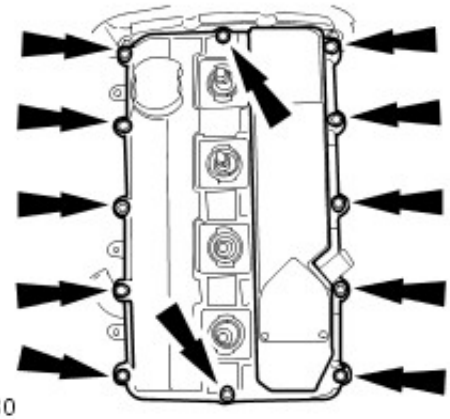
- Remove and discard the 3 bolts.



60. Using a suitable tool, remove and discard the timing cover.

- Remove the 20 bolts.
- Remove the 2 nuts.

61. Remove the valve cover.

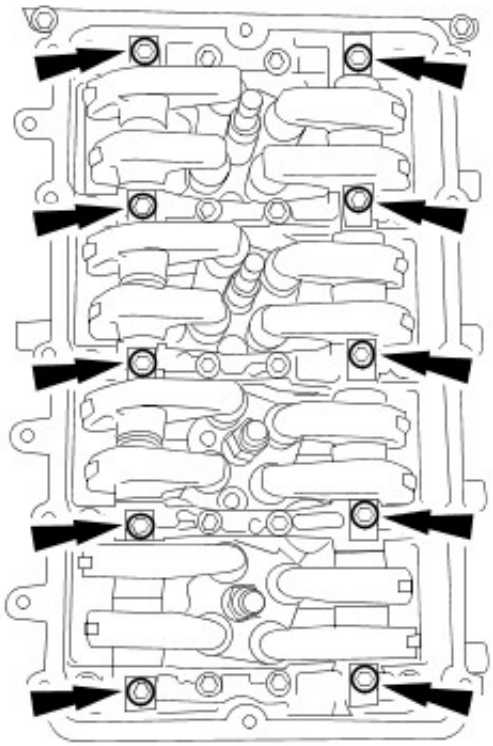


ELE0012980

- Remove the 12 bolts.
- Remove and discard the gasket.

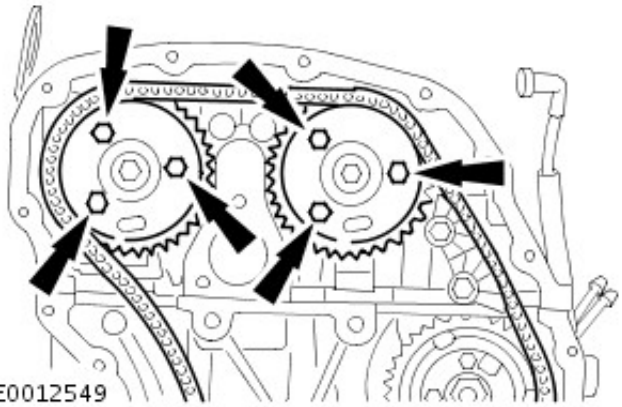
62. Remove the rocker shafts.

- Remove and discard the 10 bolts.



ELE0015429

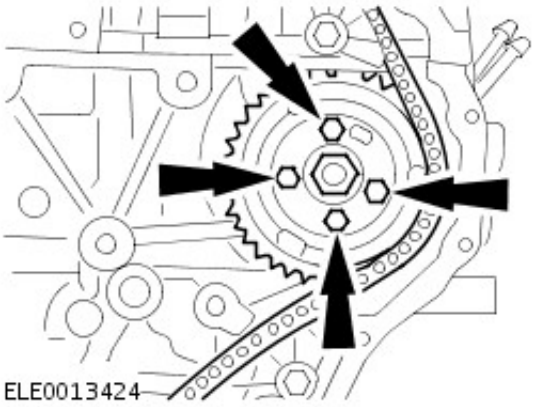
63. Loosen the 6 camshaft sprocket bolts.



ELE0012549

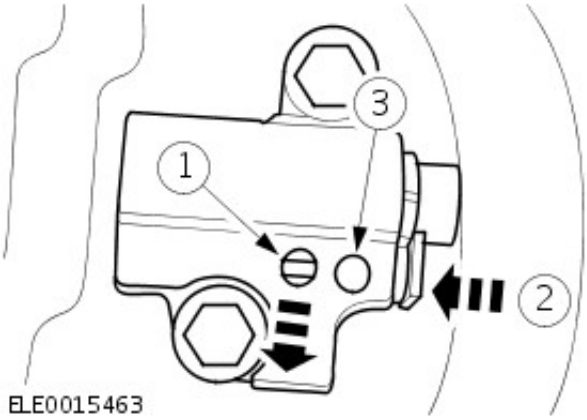
64. Loosen the 4 fuel injection pump sprocket bolts.

64. Loosen the 4 fuel injection pump sprocket bolts.



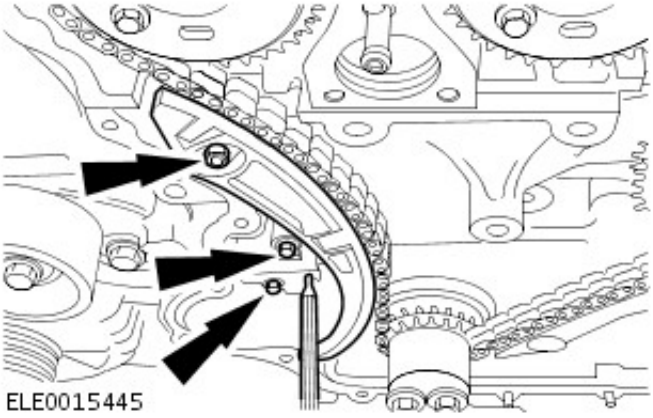
65. Detension and lock the timing chain tensioner.

1. Retract the pawl.
2. Push the lock in.
3. Insert a pin.



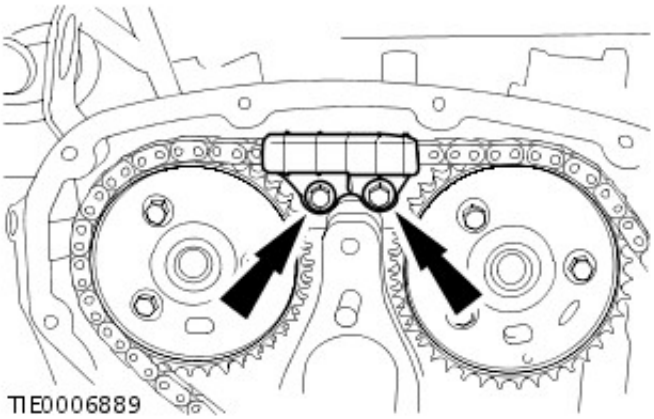
66. Remove the timing chain tensioner and the RH timing chain guide.

- Remove the 2 bolts.
- Remove the nut.

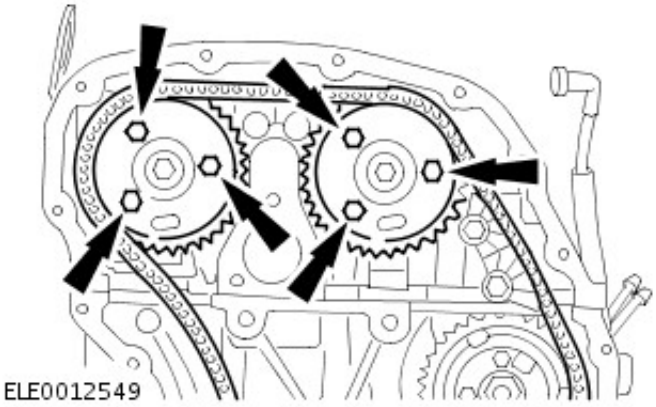


67. Remove the upper timing chain guide.

- Remove the 2 bolts.

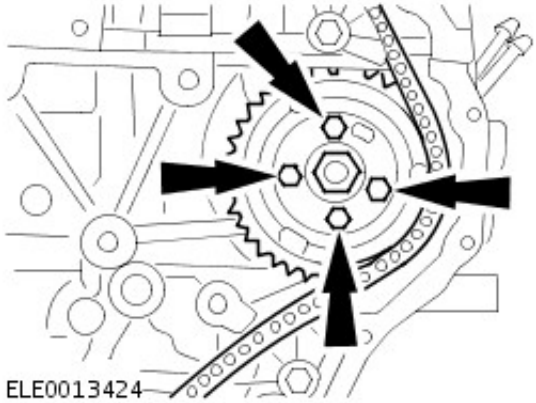


68. Remove the camshaft sprockets and the timing chain



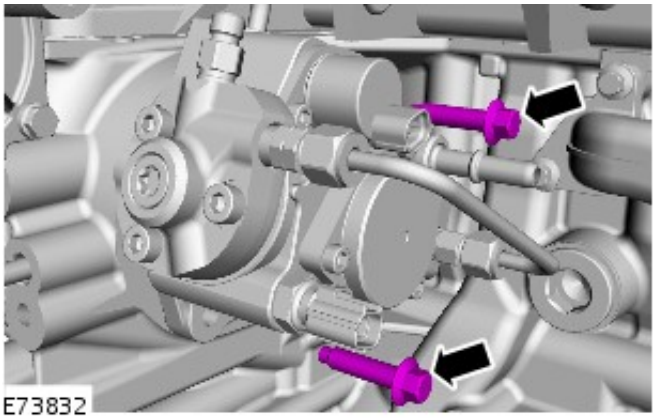
- Remove the 6 bolts.

69. Remove the fuel injection pump sprocket.

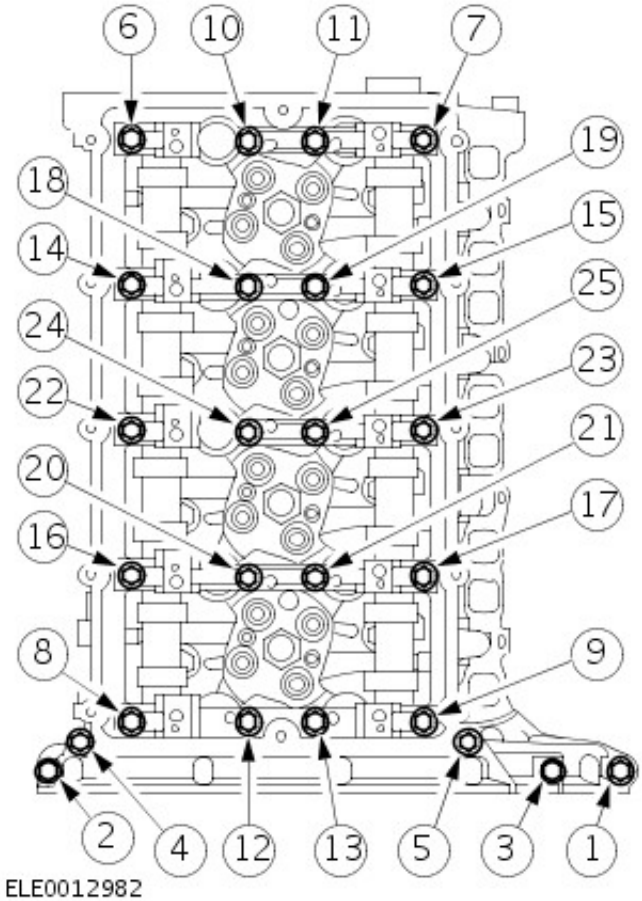


- Remove the 4 bolts.

70. Remove the fuel injection pump.



- Remove the 2 bolts.
- Remove and discard the O-ring seal.



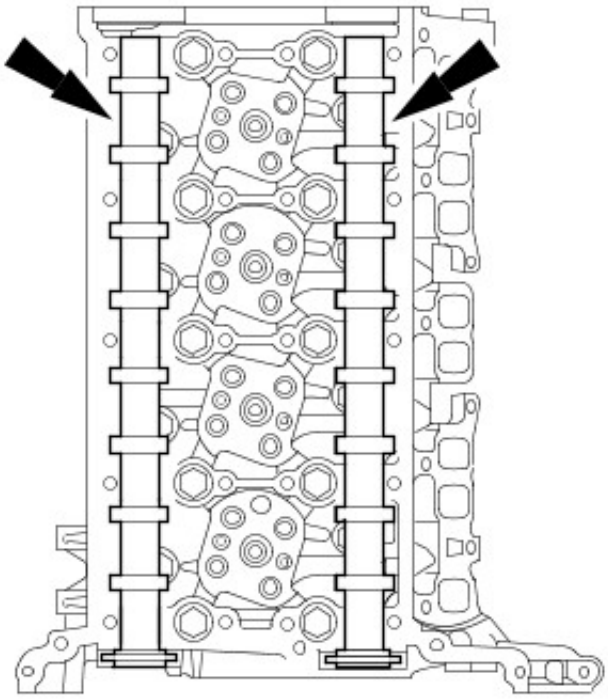
ELE0012982

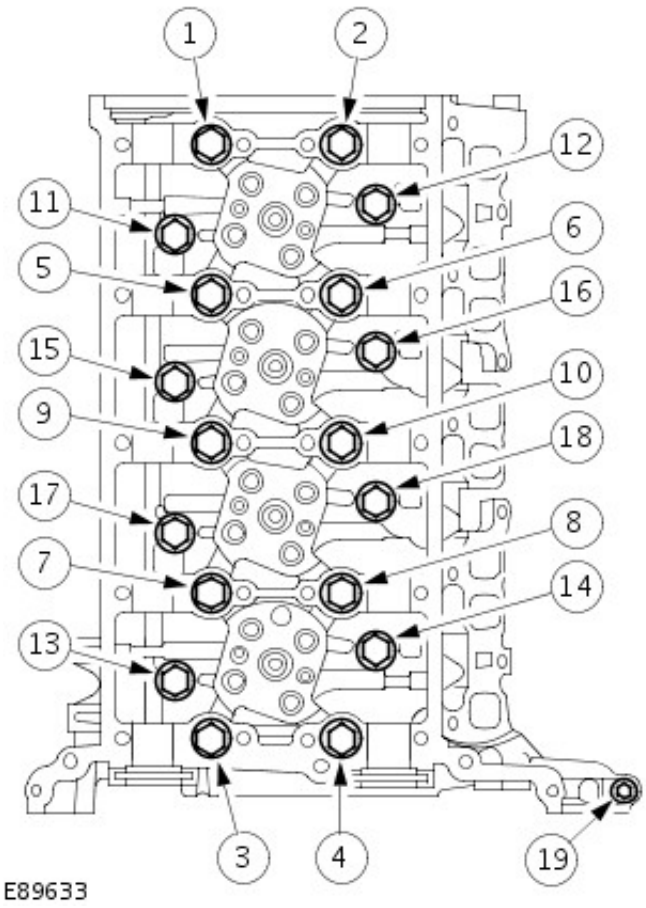
71. CAUTION: Remove the bolts in the sequence shown. Failure to follow this instruction may result in damage to the vehicle.

Remove the camshaft carrier.

- Remove the 25 bolts.

72. Remove the camshafts.


E48216

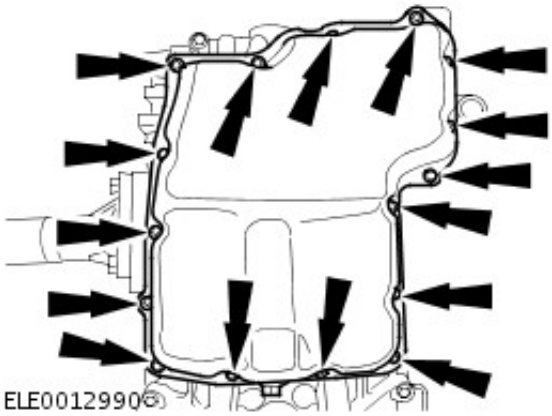


E89633

73. CAUTION: The cylinder head must not be placed face down. Failure to follow this instruction may result in damage to the vehicle.

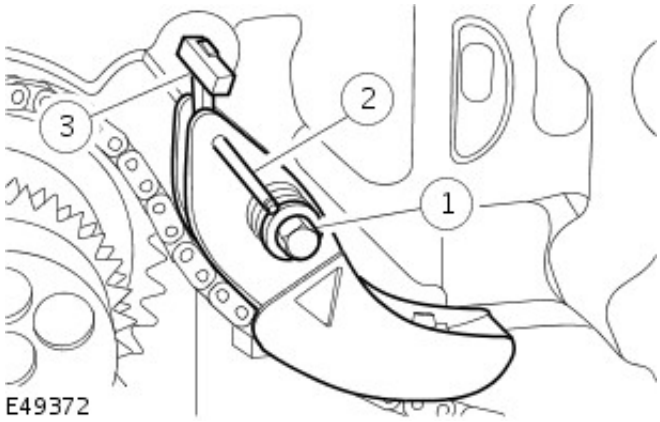
Remove the cylinder head.

- Remove and discard the bolts numbered 1 through 18.
- Remove bolt 19.
- Remove and discard the gasket.


ELE0012990

74. Remove and discard the oil pan.

- Remove the 11 bolts.
- Remove the 5 nuts.
- Remove the 5 studs.



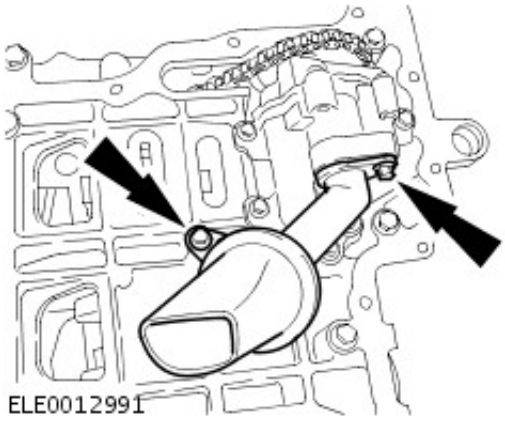
E49372

75. Remove the oil pump chain tensioner.

1. Install the bolt and tension the tensioner.
2. Lock the tensioner by inserting a pin.
3. Remove the leaf spring from the retaining stud.

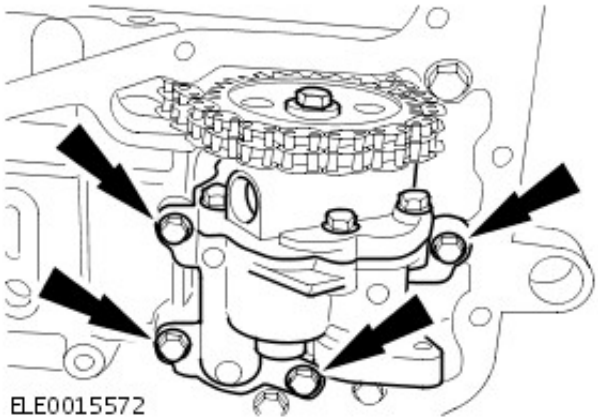
- Remove the bolt.

76. Remove the oil pump pickup tube


ELE0012991

- Remove the 2 bolts.
- Remove and discard the O-ring seal.

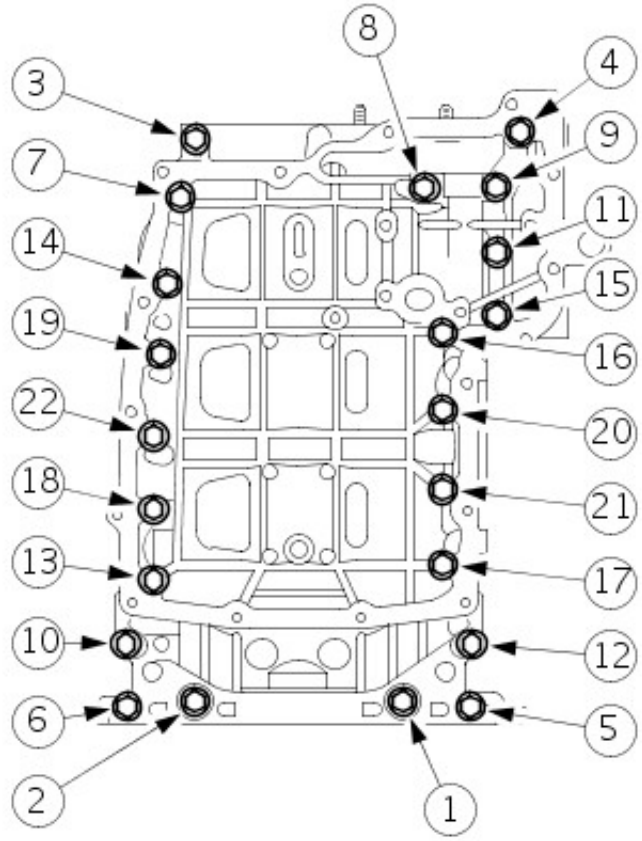
77. Remove the oil pump.


ELE0015572

- Remove the 4 bolts.
- Release the chain from the crankshaft sprocket.

78. CAUTION: Remove the ladder frame bolts in the sequence shown.

Remove the ladder frame.



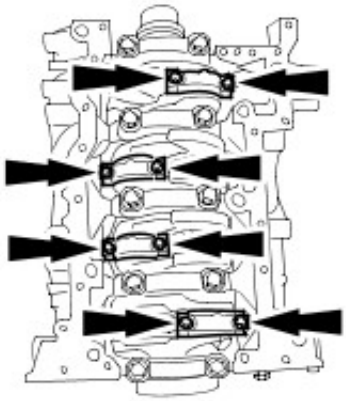
ELE0015834

- Remove the 22 bolts.
- Discard the gasket.

79. Remove the connecting rod bearing caps

79. Remove the connecting rod bearing caps.

- Remove the 8 bolts.

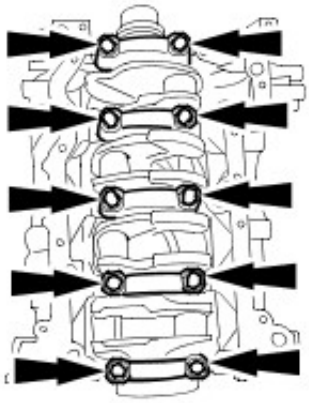


ELE0012996

80. Remove the connecting rods and pistons.

81. Remove the crankshaft main bearing caps.

- Remove the 10 bolts.

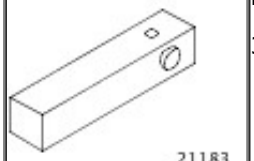
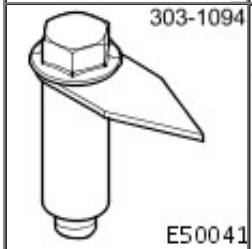
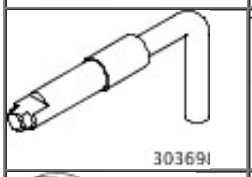
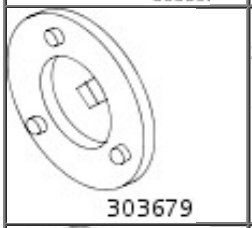
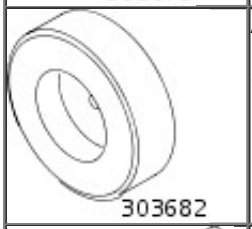
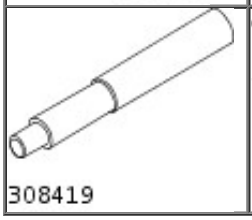


ELE0013006

82. Remove the crankshaft.

- Remove the crankshaft thrust washers.
- Remove the crankshaft main bearing shells.

Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine
Assembly

Special Tool(s)	
	Ladder Frame Alignment Tool 303-1095
	Pointer, Top Dead center (TDC) 303-1094
	Timing Tool, Crankshaft 303-698
	Remover/Installer Crankshaft Front Oil Seal 303-679
	Alignment Tool, Engine Front Cover 303-682
	Clutch Alignment Tool 308-419

Assembly

1. NOTE: The grooves in the crankshaft thrust washers must face outwards.

Install the crankshaft thrust washers.

- Lubricate the thrust washers with clean engine oil.

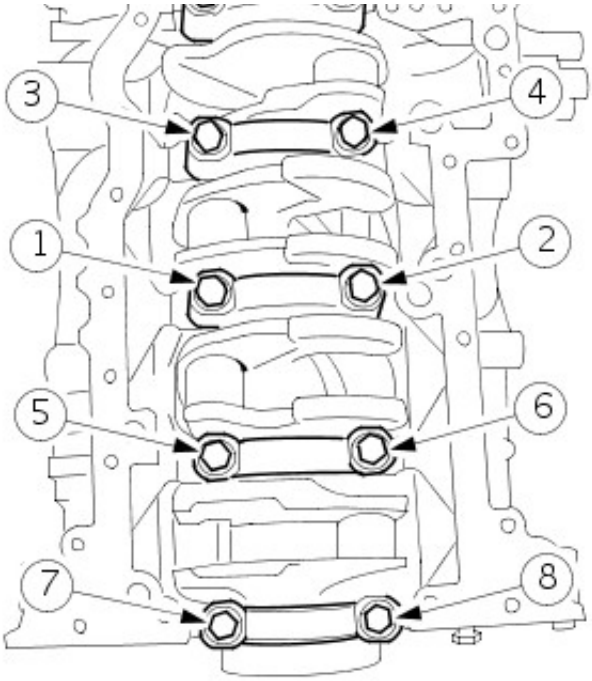
2. Install the crankshaft.

- Lubricate the crankshaft journals and the crankshaft bearing shells with clean engine oil.
- Install the crankshaft main bearing shells.

3. CAUTIONS:

Assemble caps with arrows pointing forward. Caps are identified from front to rear, F, 2, 3, 4, R.

Crankshaft main bearing cap bolts must only be used



TIE0018206

four times.

Tighten the bolts in three stages in the sequence shown.

• NOTE: Lubricate the crankshaft and the crankshaft main bearing shells with clean engine oil.

• NOTE: Stamp the bolt heads with a center punch to indicate usage.

Install the crankshaft main bearing caps.

- Stage 1: 45 Nm (33 lb.ft).
- Stage 2: 80 Nm (59 lb.ft).
- Stage 3: 105 degrees.

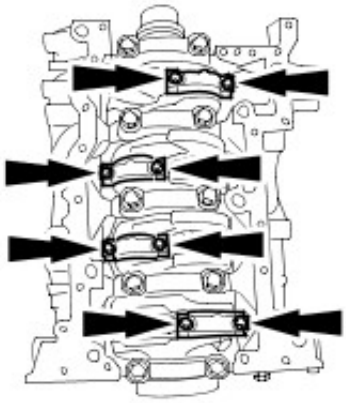
4. CAUTION: Make sure the connecting rod does not damage the crankshaft big end bearing surface.

• NOTE: The piston ring gaps must be distributed evenly around the circumference of the piston. This also applies to the oil control ring elements. Align the piston ring gaps at 120 degrees to each other.

• NOTE: The arrow on the piston must point to the front to the engine.

Using a suitable tool, install the pistons.

- Lubricate the cylinder bores and pistons with clean engine oil.



ELE0012996

5. CAUTIONS:

Connecting rod bearing cap bolts must only be used four times.

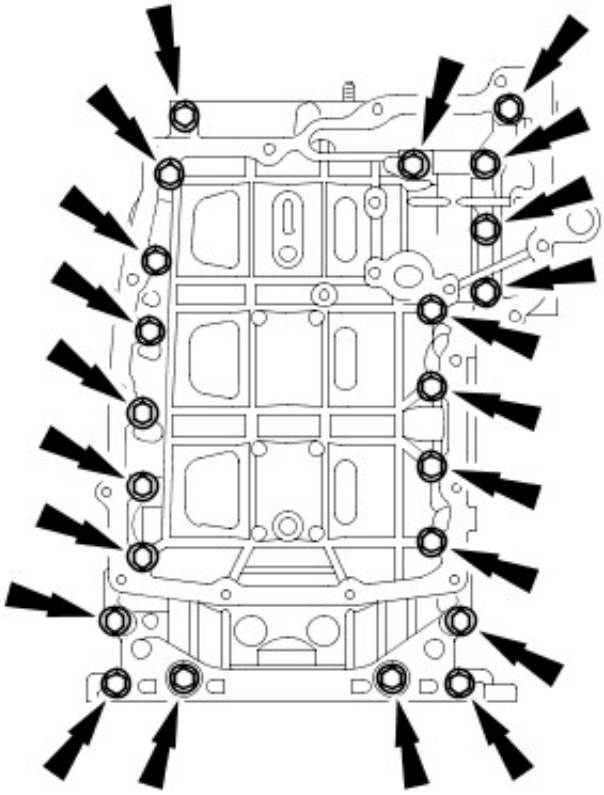
Make sure that the fracture split connecting rod bearing cap is installed correctly.

• NOTE: Stamp the bolt heads with a center punch to indicate usage.

• NOTE: The identification marks on the big-end bearing caps must point to the front of the engine.

Install the connecting rod bearing caps.

- Lubricate the connecting rod bearing shells with clean engine oil.
- Tighten the bolts in two stages.
- Stage 1: 30 Nm (22 lb.ft).
- Stage 2: 80 degrees.



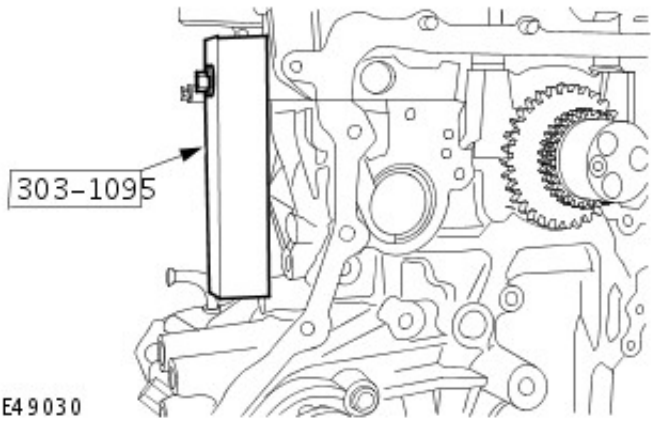
ELE0018513

6. CAUTION: Do not trim or damage protruding foam pads.

• NOTE: Install new ladder frame gaskets.

Install the ladder frame.

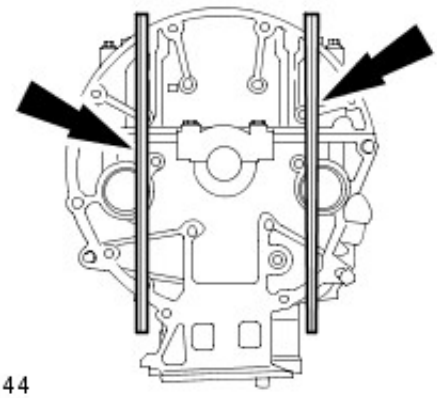
- Loosely install the bolts.



E49030

7. CAUTION: The ladder frame and the cylinder block must be aligned so that the side clearance does not exceed 0.05 mm overlap to 0.05 mm gap.

Using the special tool, align the ladder frame to the cylinder block.

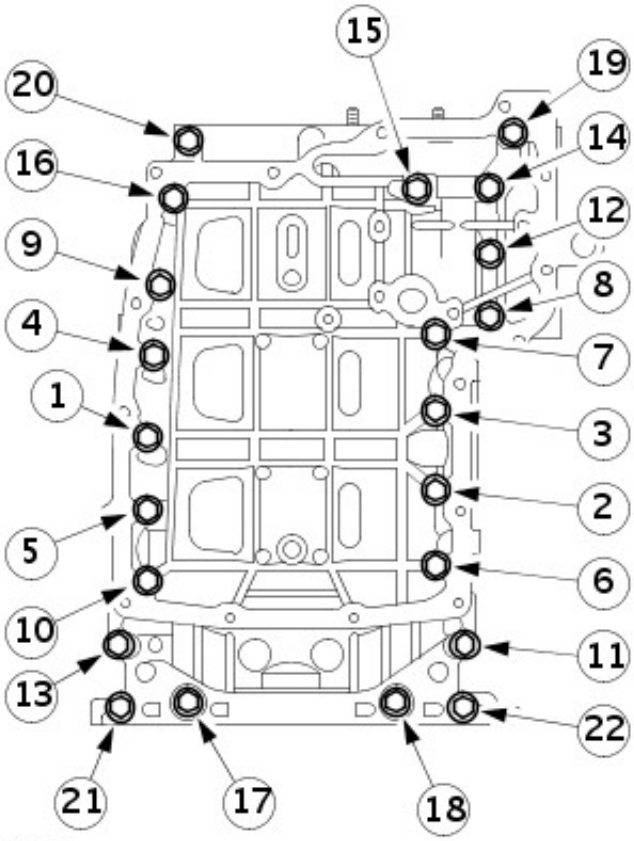


ELE0013444

8. CAUTION: The ladder frame and the cylinder block must be aligned so that the rear clearance does not exceed 0.01 mm overlap to 0.2 mm gap.

Using a suitable straight edge, align the ladder frame to the cylinder block.

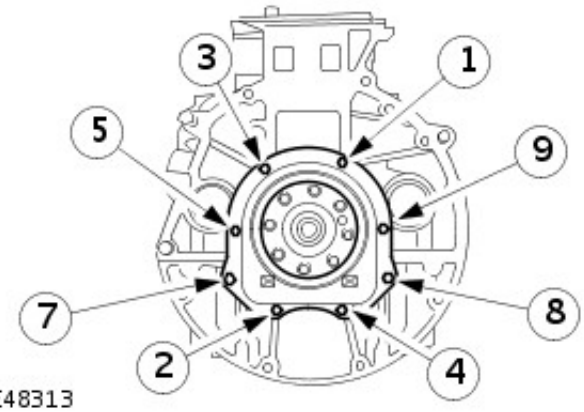
9. NOTE: Tighten the bolts in the sequence shown.



E48312

Secure the ladder frame.

- Tighten the bolts to 23 Nm (17 lb.ft).



E48313

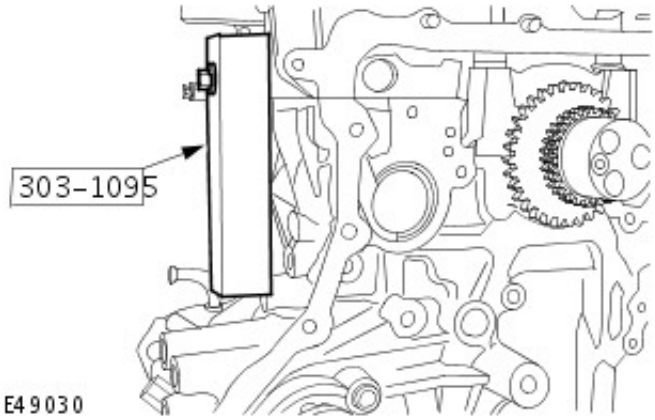
10. NOTE: Install a new crankshaft rear seal.

• NOTE: A new crankshaft rear seal is supplied with an alignment sleeve that must be removed following installation.

• NOTE: Tighten the bolts in the sequence shown.

Install the crankshaft rear seal.

- Tighten the bolts to 10 Nm (7 lb.ft).

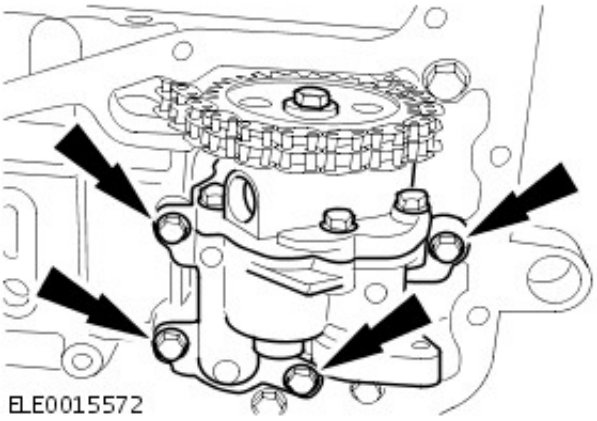


E49030

11. Remove the special tool.

- Remove the bolt.

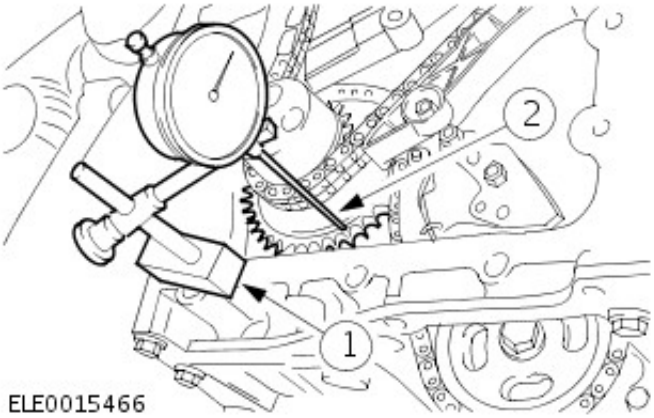
12. NOTE: Do not fully tighten the oil pump bolts at this



stage.

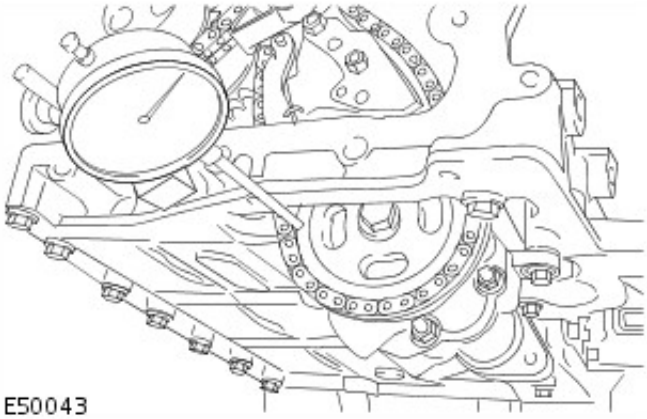
Install the oil pump and oil pump chain.

- Install the oil pump chain to the crankshaft sprocket.



13. Using a suitable dial indicator gauge take a reference measurement from the front face of the crankshaft sprocket.

1. Position the dial gauge holding fixture on the cylinder block.
2. Position the dial indicator gauge plunger on the crankshaft sprocket and set the dial to zero.



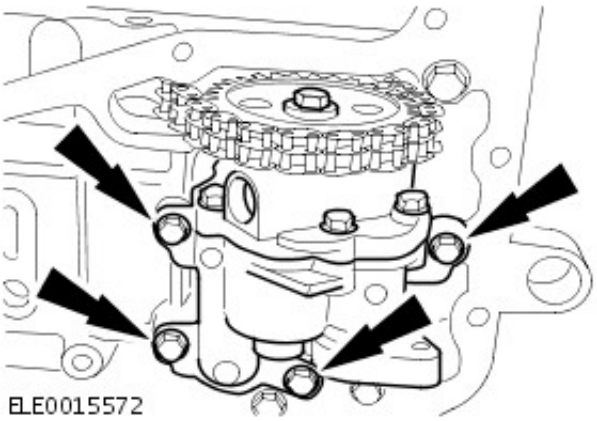
14. NOTE: Take measurements at two different points on the oil pump sprocket.

Using the dial indicator gauge align the oil pump sprocket and tighten the oil pump bolts.

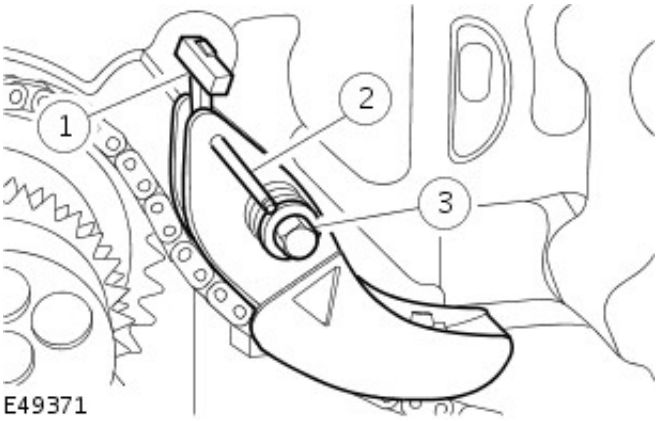
15. Check the alignment of the oil pump sprocket with the crankshaft sprocket. Repeat the alignment procedure if necessary.

16. Secure the oil pump.

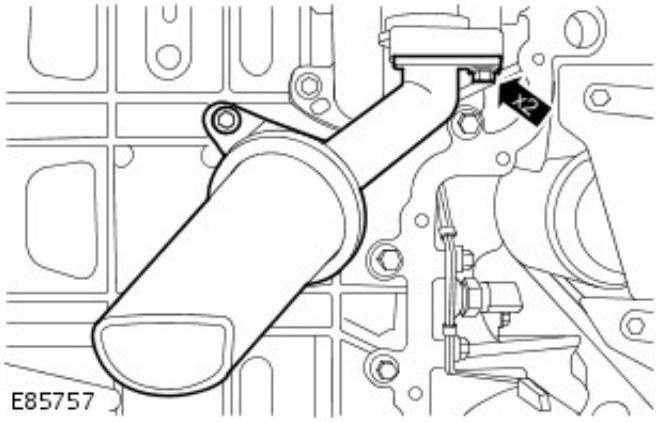
- Tighten the bolts to 10 Nm (7 lb.ft).



17. Install the oil pump chain tensioner.



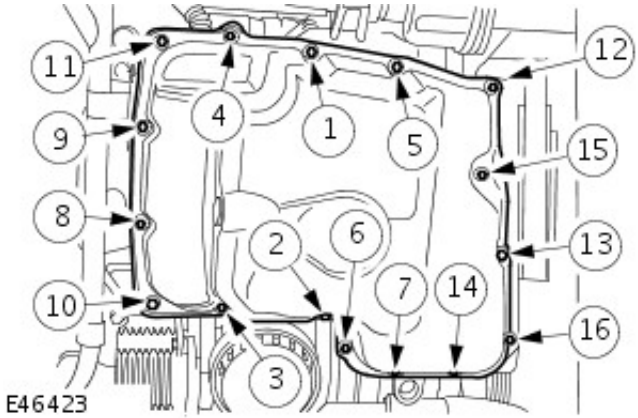
1. Install the spring to the stud.
2. Unlock the tensioner by removing the pin.
3. Tighten the bolt 22 Nm (16 lb.ft).



18. NOTE: Install a new O-ring seal.

Install the oil pump pickup tube.

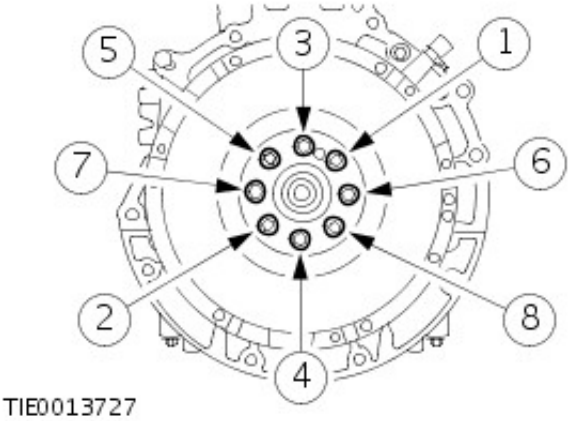
- Tighten the bolts to 10 Nm (7 lb.ft).



19. NOTE: Tighten the bolts in the sequence shown in two stages.

Install the new oil pan.

- Apply a 3 mm bead of the specified sealant to the oil pan.
- Stage 1: Tighten bolts 1 through 16 to 7 Nm.
- Stage 2: Tighten bolts 1 through 16 to 14 Nm.



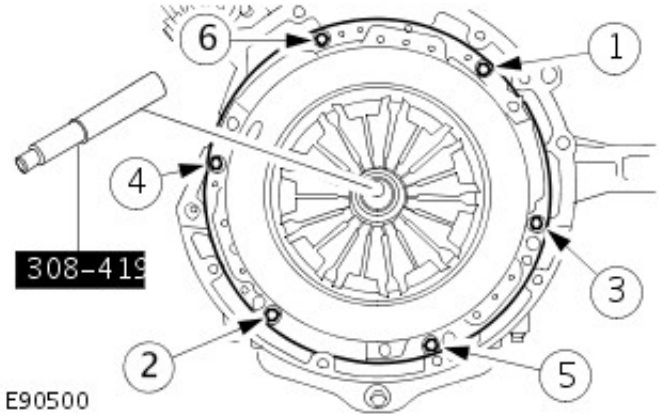
20. NOTE: Install new flywheel bolts.

• NOTE: Tighten the bolts in the sequence shown in three stages.

Install the flywheel.

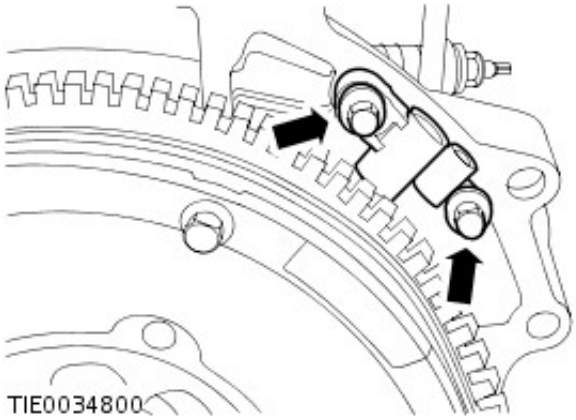
- Stage 1: 25 Nm (18 lb.ft).
- Stage 2: 40 Nm (30 lb.ft).
- Stage 3: 48 degrees.

21. NOTE: Tighten the bolts in the sequence shown.



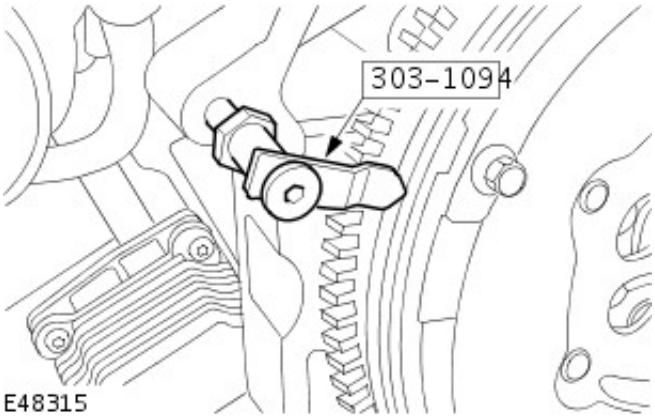
Using the special tool, install the clutch disc and pressure plate.

- Tighten the bolts to 29 Nm (21 lb.ft).



22. NOTE: Do not fully tighten the crankshaft position sensor bracket bolts at this stage.

Install the crankshaft position (CKP) sensor bracket.



23. NOTE: After installation do not move the special tool.

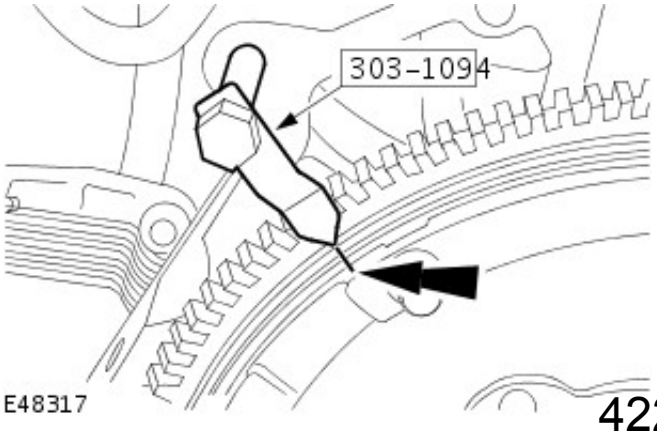
Install the special tool.

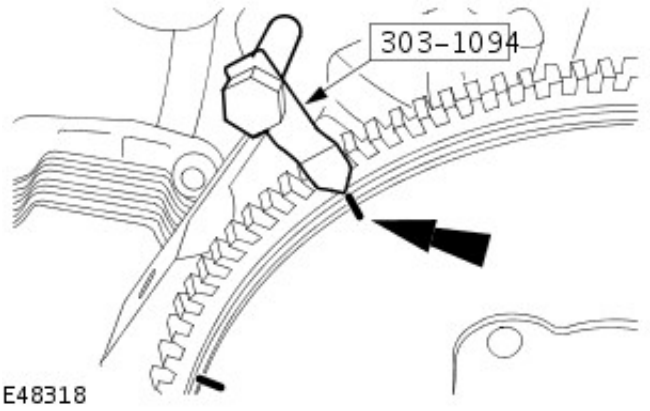
24. Rotate the crankshaft until piston number one is approximately 10 mm before top dead center (BTDC).

25. Position a dial gauge on the cylinder block.

- Position the dial indicator gauge plunger on to piston number 1.
- Zero the dial indicator gauge.

26. Mark the position on the flywheel.



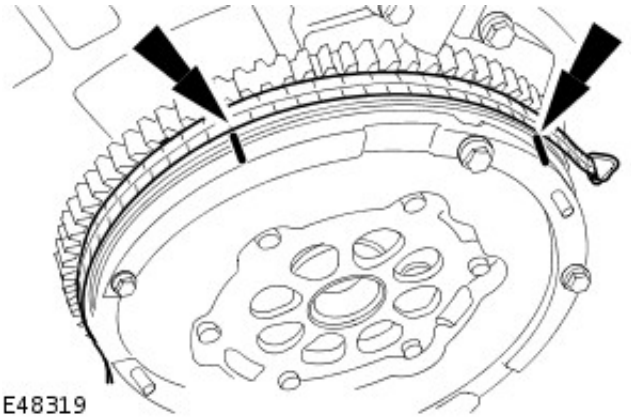


27. NOTE: Rotate the flywheel counterclockwise.

Rotate the crankshaft until the piston number one achieves zero on the dial indicator gauge.

- Mark the position on the flywheel.

28. Repeat the previous steps to make sure that the marking is correct.

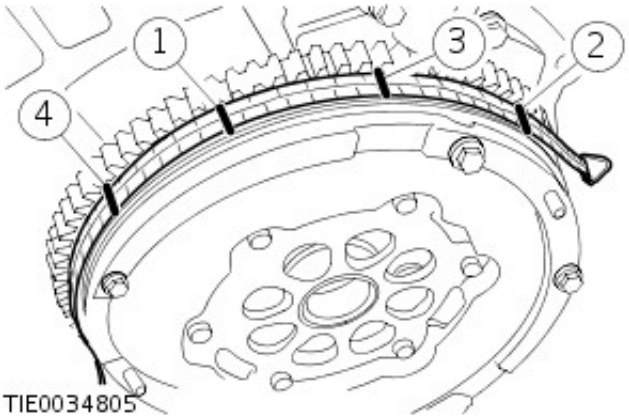


29. NOTE: The middle of the markings is top dead center (TDC).

Measure the distance between the two marks.

30. Divide the amount by two and mark the TDC position on the flywheel primary mass.

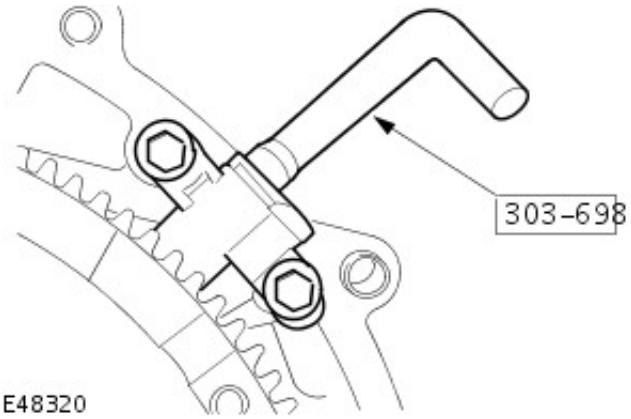
31. Measure the circumference of the flywheel.



32. NOTE: Mark the calculated amount on the flywheel by measuring from TDC counterclockwise.

Multiply the circumference by 0.1388.

1. First mark.
2. Second mark.
3. Determined TDC.
4. Determined 50 degrees BTDC.

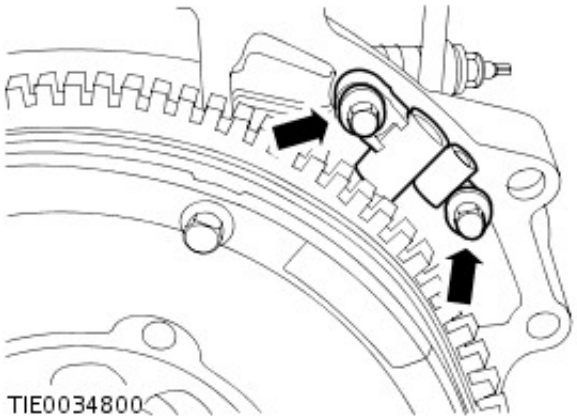


33. NOTE: Rotate the crankshaft in the normal direction of rotation to the mark of the calculated 50 degrees BTDC.

Install the special tool.

34. Secure the crankshaft position (CKP) sensor bracket.

- Tighten the bolts to 23 Nm (17 lb.ft).



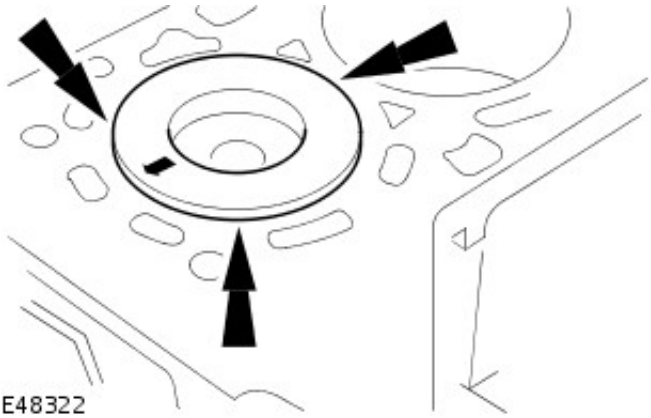
35. NOTE: Clean the component mating face.

• NOTE: Measure the piston protrusion of each cylinder at TDC.

• NOTE: The largest measurement determines the choice of the cylinder head gasket.

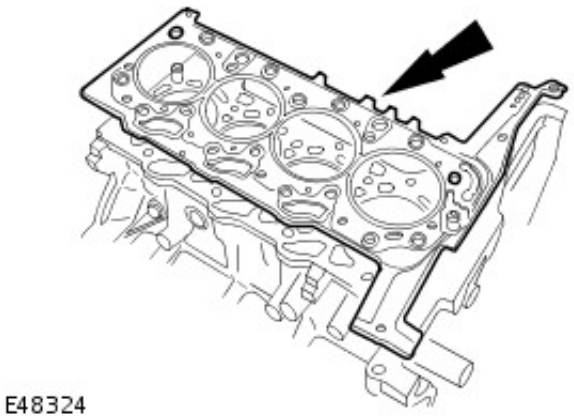
Measure the distance between the piston crown and the cylinder block at the points indicated.

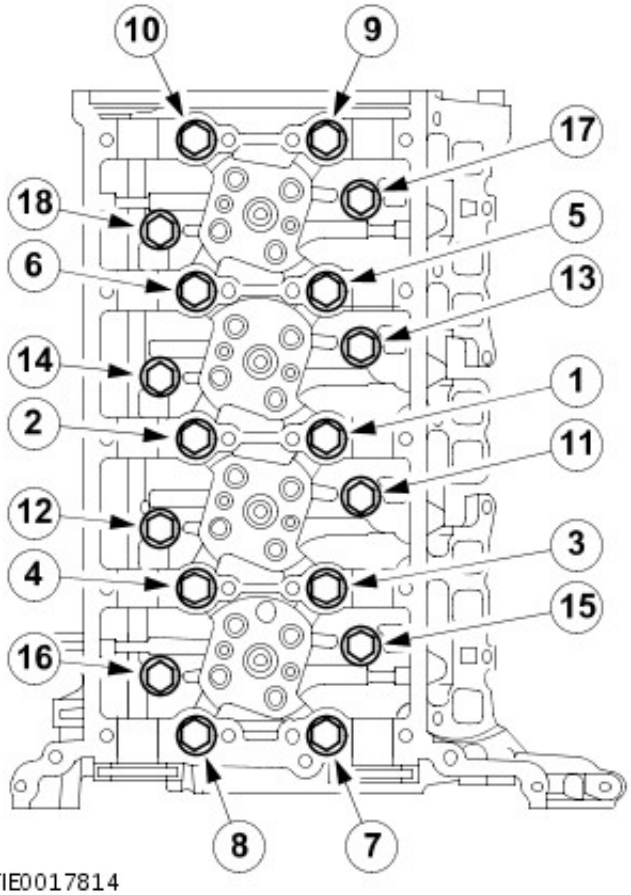
- Using the specification table determine the correct cylinder head gasket.
  For additional information, refer to: Specifications (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).



36. CAUTION: The thickness of the new cylinder head gasket depends on the piston protrusion (hole/tooth marked).

Install a new cylinder head gasket.





TIE0017814

37. CAUTION: Install new cylinder head bolts.

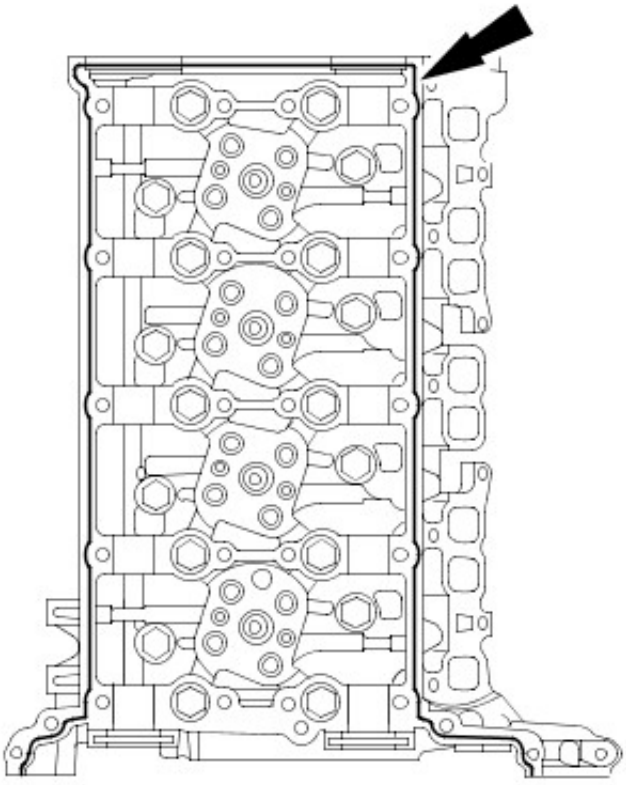
• NOTE: Clean the component mating face.

Install the cylinder head.

- Tighten the bolts in the sequence shown in six stages.
- Stage 1: Tighten bolts 1 through 10 to 20 Nm.
- Stage 2: Tighten bolts 11 through 18 to 10 Nm.
- Stage 3: Tighten bolts 1 through 10 to 40 Nm.
- Stage 4: Tighten bolts 11 through 18 to 20 Nm.
- Stage 5: Tighten bolts 1 through 10 to 180 degrees.
- Stage 6: Tighten bolts 11 through 18 to 180 degrees.
- Stage 7: Tighten the M6 bolt to 10 Nm (7 lb.ft).

38. NOTE: Clean the component mating face.

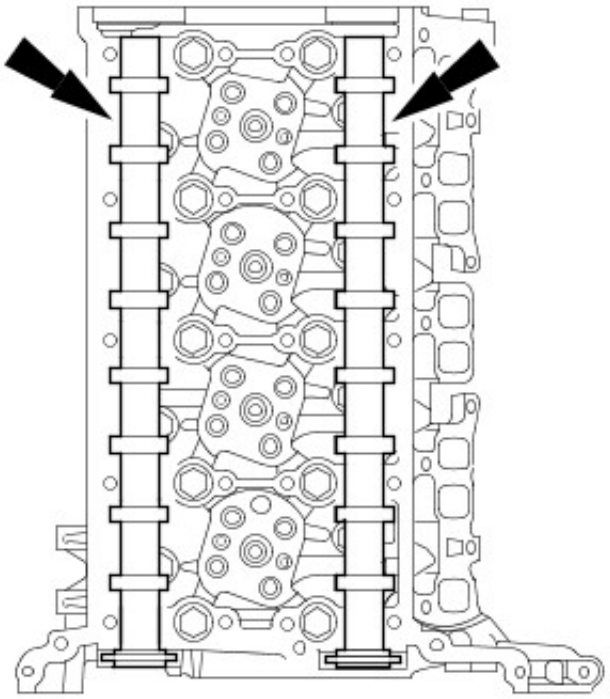
Apply a 2.5 mm (0.1 inches) diameter bead of the specified sealant to the cylinder head.


ELE0013422

39. NOTE: Clean the component mating faces

Install the camshafts.

- Lubricate the camshaft journals and the camshaft lobes with clean engine oil.

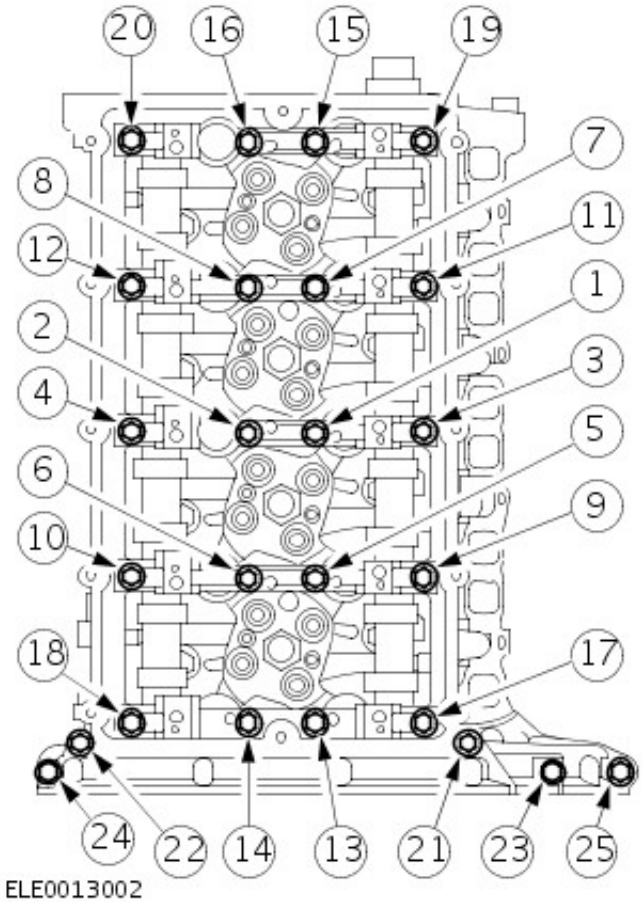


E48216

40. NOTE: Tighten the bolts in the sequence shown in two stages.

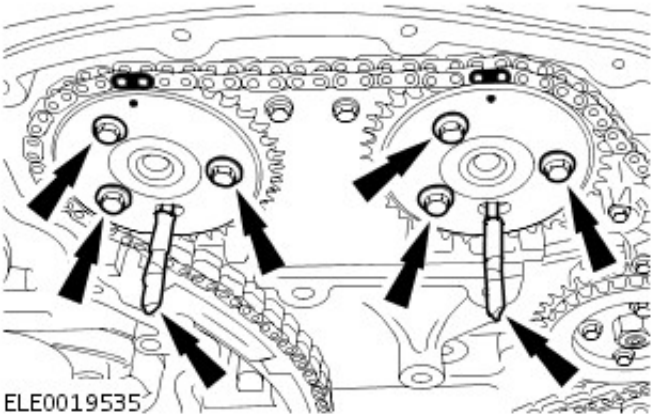
Install the camshaft carrier.

- Stage 1: Tighten bolts 1 through 22 to 23 Nm.
- Stage 2: Tighten bolts 23 through 25 to 10 Nm.



ELE0013002

41. Using suitable 6 mm bar, lock the camshaft sprockets.



- Loosely install the camshaft sprocket bolts.

42. CAUTIONS:

⚠ New bolts must be installed.

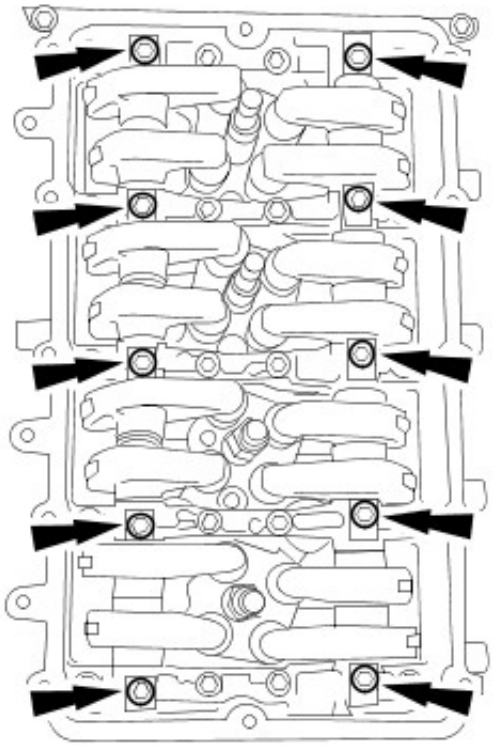
⚠ Tighten the bolts in the stages shown.

• NOTE: Lubricate the rocker shafts with clean engine oil.

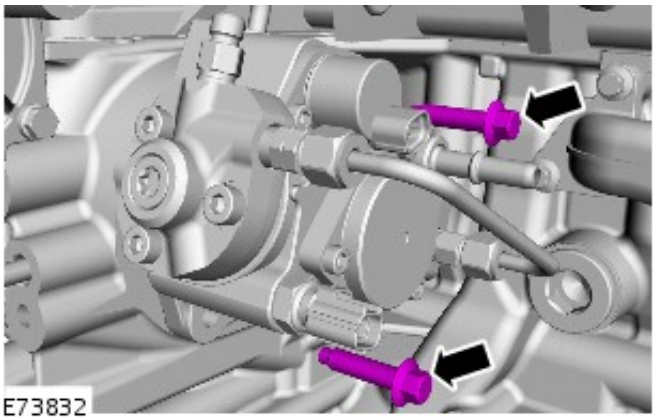
• NOTE: The oil supply holes in the rocker shafts must point down.

Install the rocker shafts.

- Stage 1: Tighten the bolts to 13 Nm (10 lb.ft).
- Stage 2: 45 degrees.



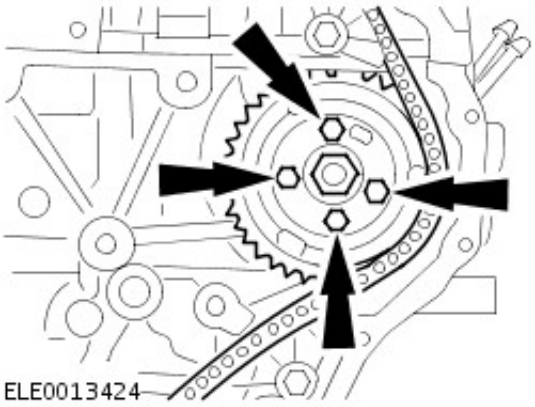
ELE0015429



43. Install the fuel injection pump.

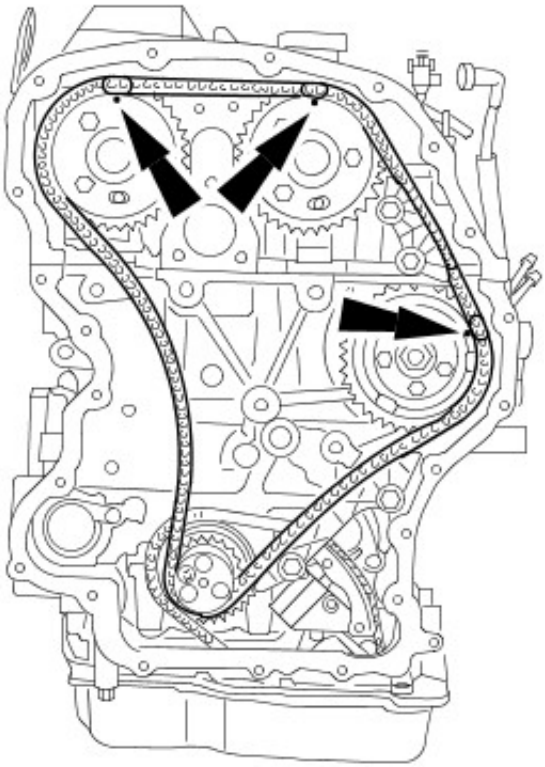
- Tighten the bolts to 22 Nm (16 lb.ft).

44. NOTE: Do not tighten the bolts at this stage



Install the fuel injection pump sprocket.

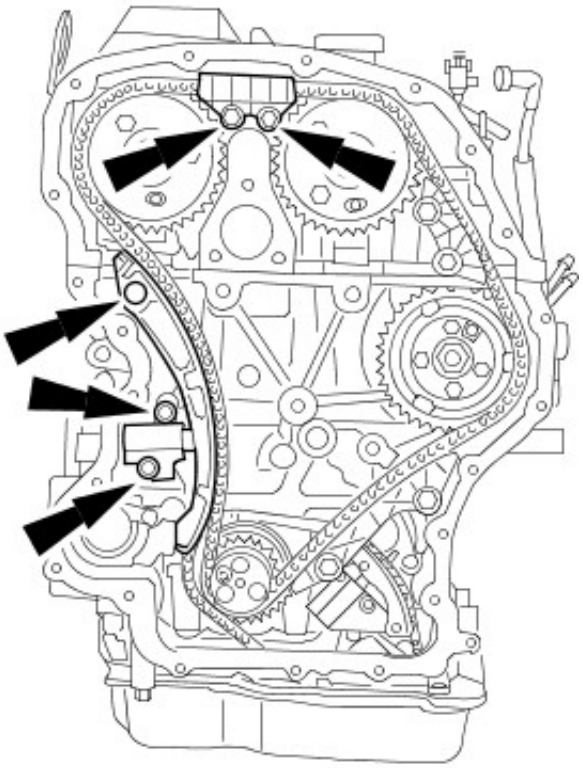
- Loosely install the bolts.



E46627

45. CAUTION: Make sure the colored links align to the timing marks. Failure to follow this instruction may result in damage to the vehicle.

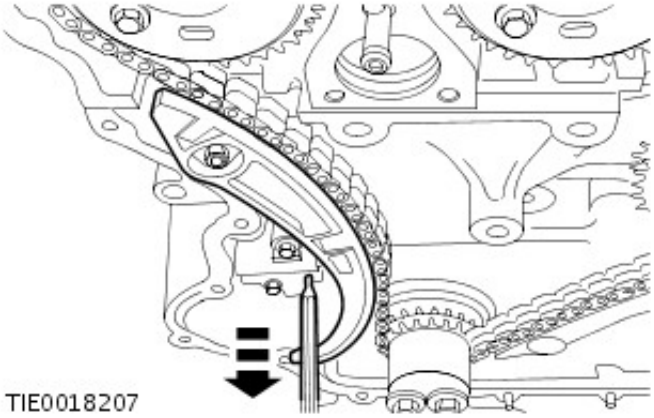
Install the timing chain.



46. CAUTION: Make sure the timing chain tensioner is fully retracted before installation. Failure to follow this instruction may result in damage to the vehicle.

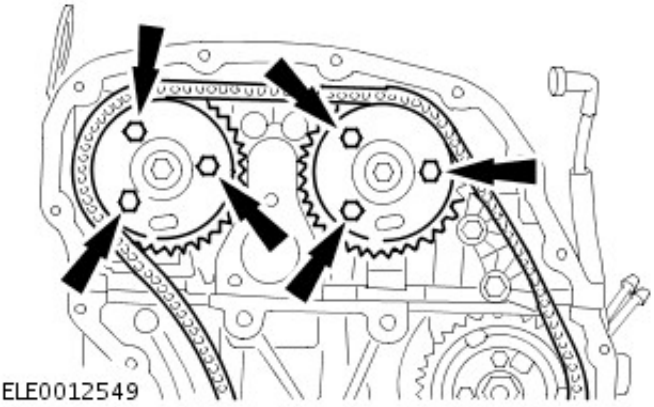
Install the timing chain tensioner and the timing chain guides.

- Tighten the bolts to 15 Nm (11 lb.ft).
- Tighten the nut to 15 Nm (11 lb.ft).



47. Unlock the timing chain tensioner.

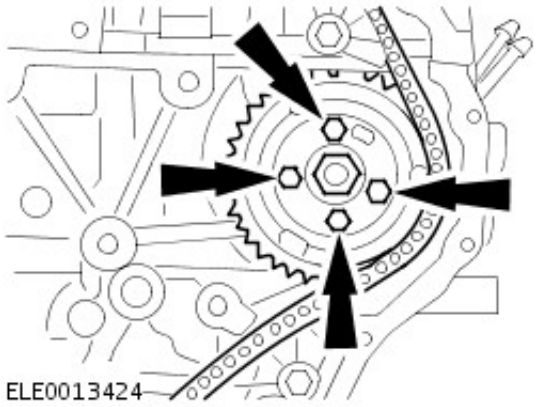
- Remove the pin.



48. Tighten the camshaft sprocket bolts to 35 Nm (24 lb.ft).

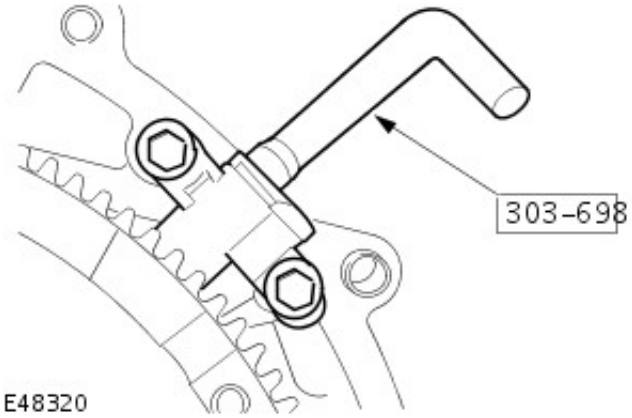
49. Tighten the fuel injection sprocket bolts to 33 Nm (26

lb.ft).



50. Remove the 6 mm bars.

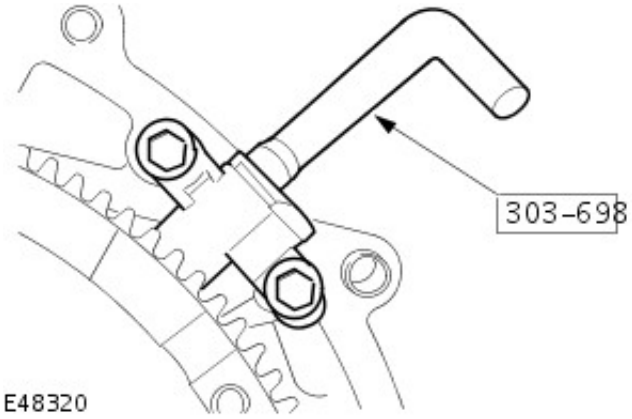
51. Remove the special tool.



52. Rotate the crankshaft clockwise 2 complete revolutions.

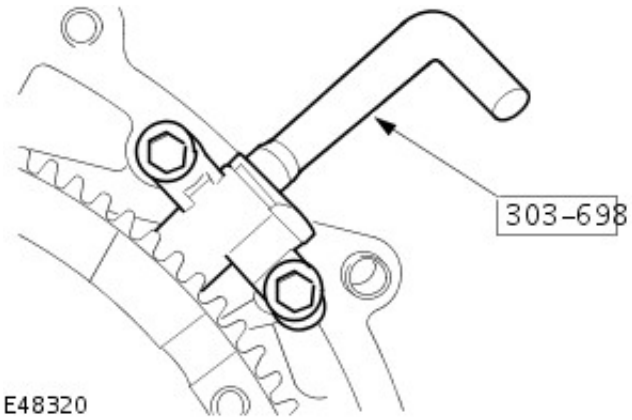
53. CAUTION: Make sure the special tool is fully located in the flywheel.

Check the timing by inserting the special tool in the CKP sensor hole.



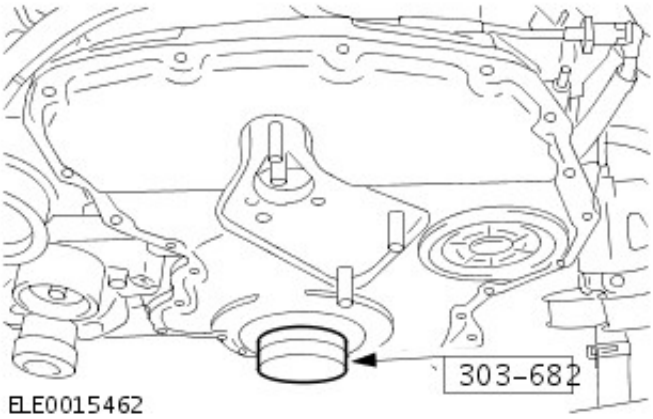
54. Check the camshaft timing by inserting a suitable 6 mm bar through the holes in the camshaft sprockets.

55. Remove the special tool.



56. Remove the 6 mm bars.

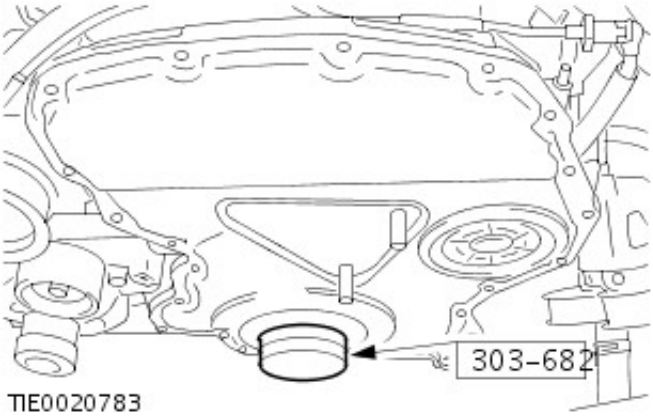
57. NOTE: Clean the component mating faces.



Using the special tool, install the new timing cover.

- Apply a 3 mm diameter bead of the specified sealant to the timing cover.
- Tighten the bolts to 14 Nm (10 lb.ft).
- Tighten the nuts to 10 Nm (7 lb.ft).

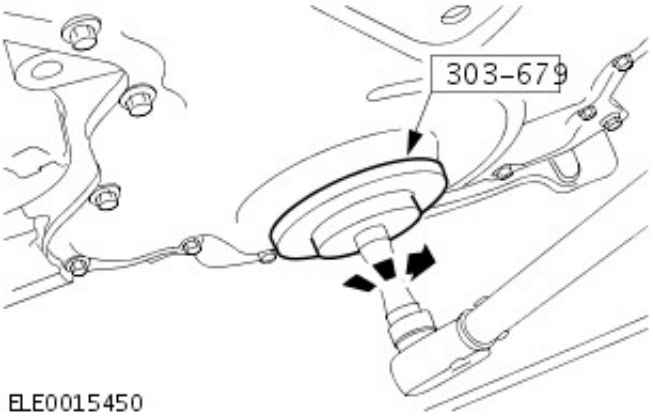
58. Remove the special tool.



59. NOTE: Install a new crankshaft front oil seal.

• NOTE: A new crankshaft front oil seal is supplied with an alignment sleeve that will be pushed out during installation.

Using the special tool, install the crankshaft front seal.



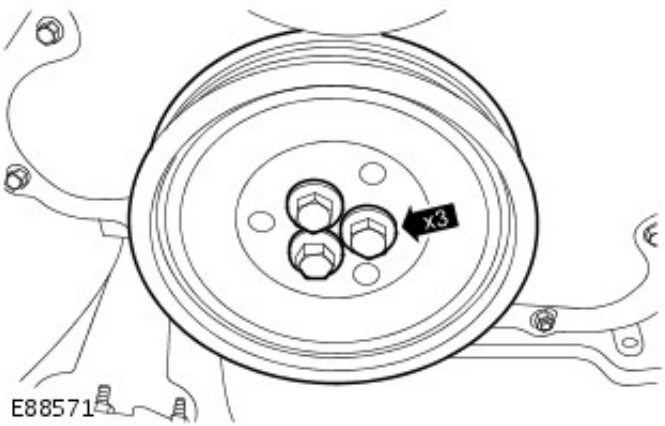
60. CAUTIONS:

Tighten the bolts in stages shown.

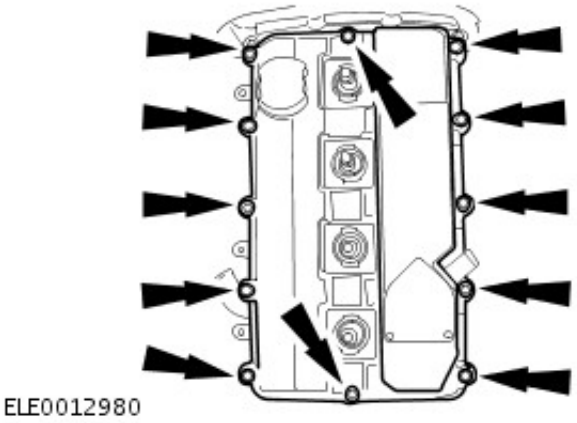
New bolts must be installed.

Install the crankshaft pulley.

- Stage 1: 45 Nm (33 lb.ft) .
- Stage 2: 120 degrees.



61. NOTE: Install a new valve cover gasket.


ELE0012980

Install the valve cover.

- Tighten the bolts to 10 Nm (7 lb.ft).

62. Install the CKP sensor.

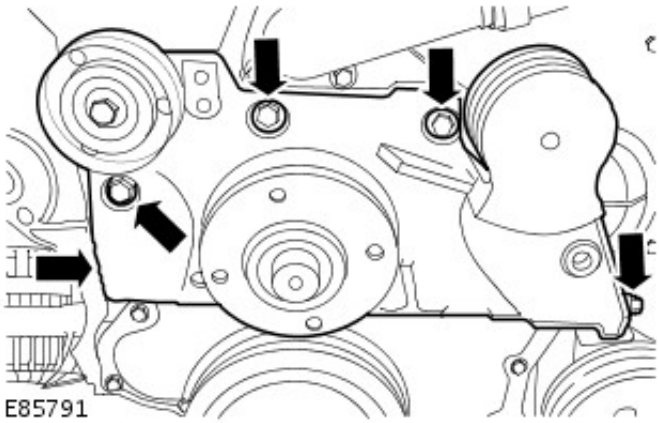
- Tighten the bolt to 7 Nm (5 lb.ft).

E88983

63. NOTE: Clean the component mating faces.

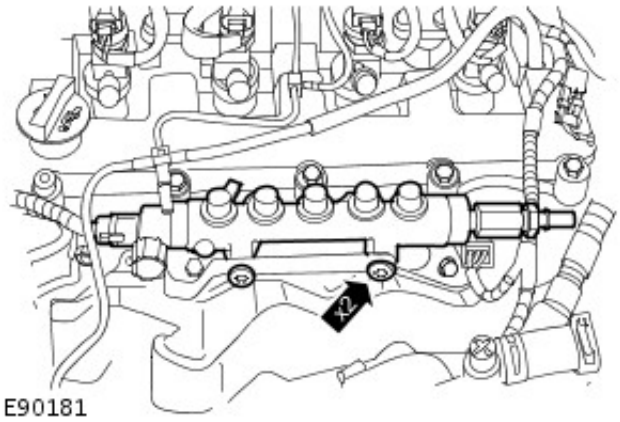
Install the cylinder head coolant outlet elbow.

- Install a new O-ring seal.
- Tighten the nut to 22 Nm (16 lb.ft).
- Tighten the bolts to 22 Nm (16 lb.ft).


E85791

64. Install the accessory drive component bracket.

- Tighten the M10 bolts to 48 Nm (35 lb.ft).
- Tighten the M8 bolt to 22 Nm (16 lb.ft).



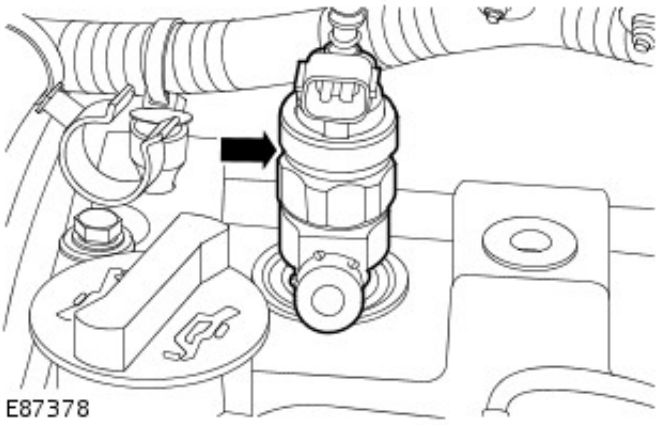
E90181

65. CAUTION: Only tighten the bolts finger-tight at this stage.

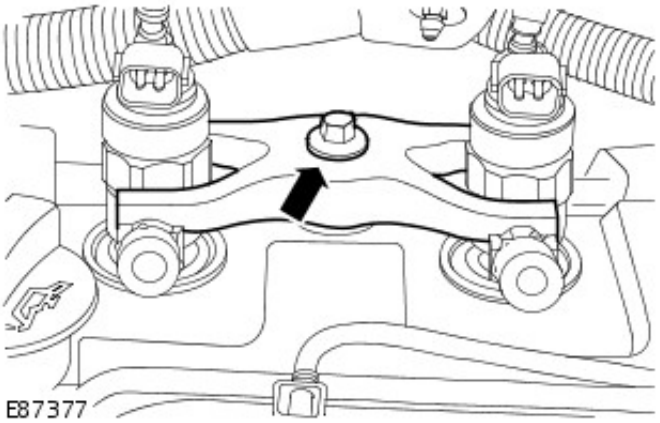
Install the fuel rail.

- Install the bracket.
- Loosely install the bolts.

66. Install the injectors



- Install new sealing washers.



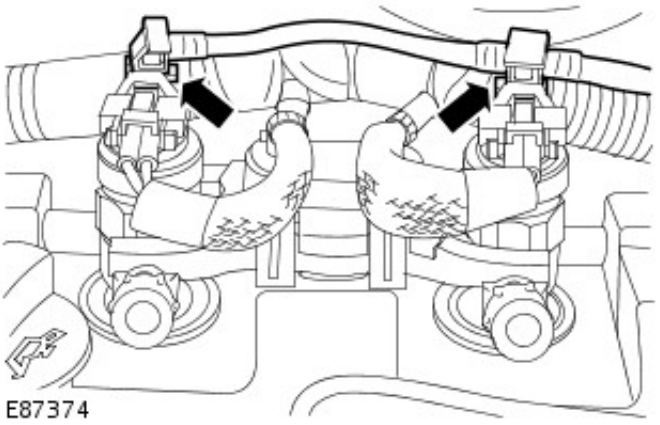
67. CAUTIONS:

The injector clamp bolts must only be used two times.

Tighten the bolts in the stages shown.

Secure the injectors.

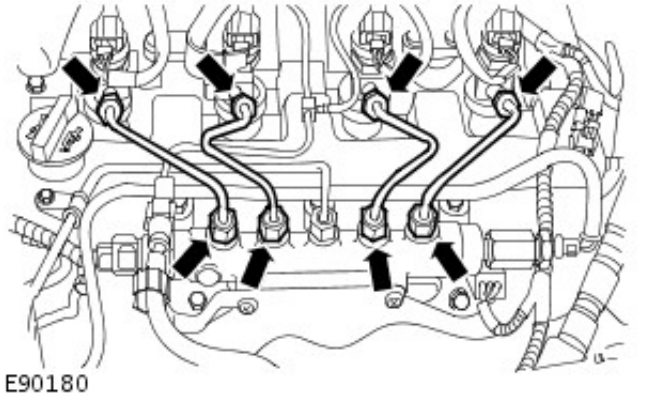
- Install the injector clamps.
- Stage 1: Tighten the bolts to 6 Nm (4 lb.ft).
- Stage 2: 180 degrees.
- Install the injector clamp covers.



68. CAUTION: Remove and discard the blanking caps.

Connect the injector spill rail.

- Install the clips.



69. CAUTIONS:

Maintain pressure on the high-pressure fuel supply line to keep the olives in contact with the fuel injectors and the fuel rail cones while installing unions.

Do not allow the unions to hit the olive ends of the high-pressure fuel supply line as this may damage the ends of the high-pressure fuel supply line and allow foreign matter to enter the fuel injection system.

Only tighten the unions finger-tight at this stage.

• NOTE: Remove and discard the blanking caps.

Install the new high-pressure fuel supply lines.

70. CAUTIONS:

Tighten the high-pressure fuel supply lines in the stages shown.

Remove and discard the blanking caps.

Secure the high-pressure fuel supply lines.

- Stage 1: Tighten the high-pressure fuel supply line unions at the fuel injectors and the fuel injection pump to 35 Nm (26 lb.ft).
- Stage 2: Tighten the high-pressure fuel supply line clips to 10 Nm (7 lb.ft).
- Stage 3: Tighten the fuel rail bolts to 23 Nm (17 lb.ft).
- Stage 4: Tighten the high-pressure fuel supply line unions at the fuel rail to 35 Nm (26 lb.ft).

71. Install the engine wiring harness.

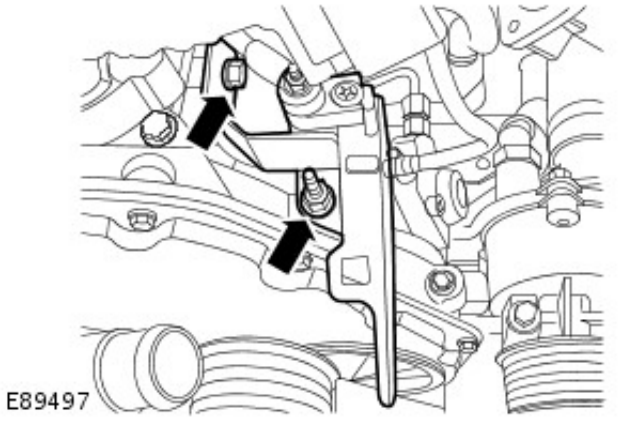
72. Connect the glow plug wiring harness.

- Tighten the nuts to 2 Nm (1 lb.ft).

E89632

73. Secure the engine wiring harness support bracket.

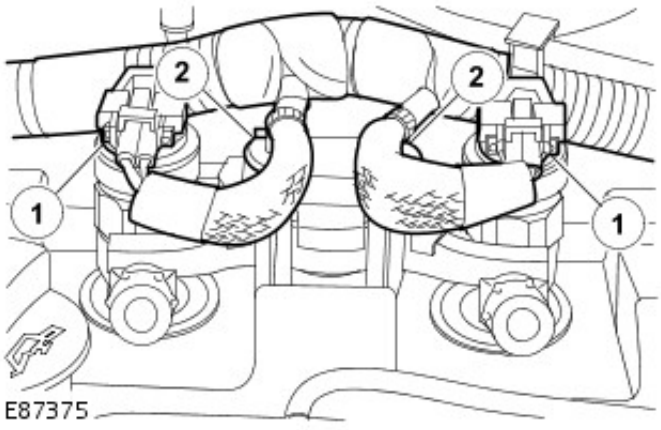
- Tighten nut to 10 Nm (7 lb.ft).
- Tighten bolt to 10 Nm (7 lb.ft).



E89497

74. Connect the injector electrical connectors.

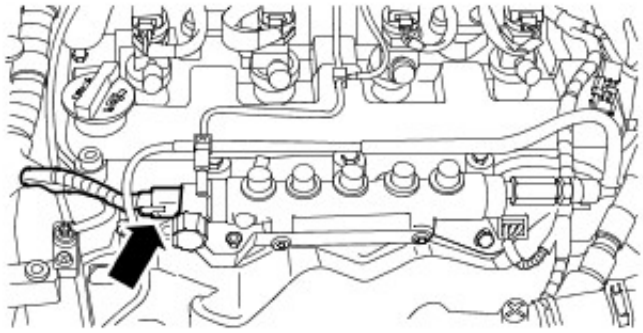
- Secure the injector wiring harness.
- Secure the clips.



E87375

75. Connect the fuel rail pressure sensor (FRP) electrical

connector.

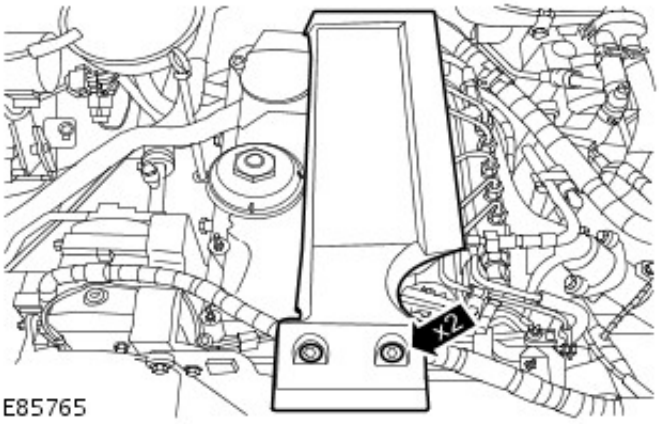


E90178

76. NOTE: Make sure the engine wiring harness is routed correctly.

Install the engine cover.

- Tighten the bolts to 10 Nm (7 lb.ft).

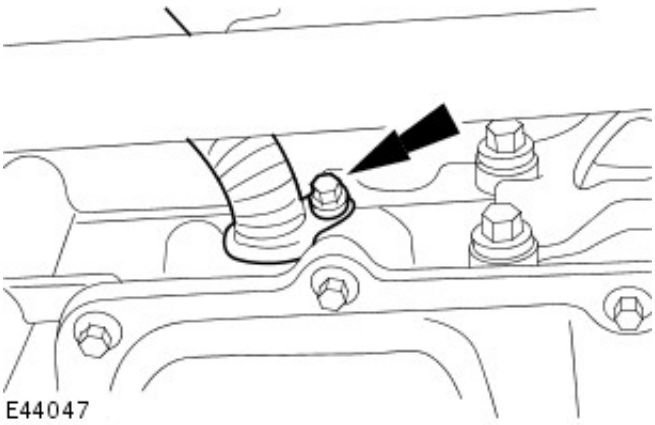


E85765

77. CAUTION: Remove and discard the blanking caps.

Install the turbocharger oil return tube.

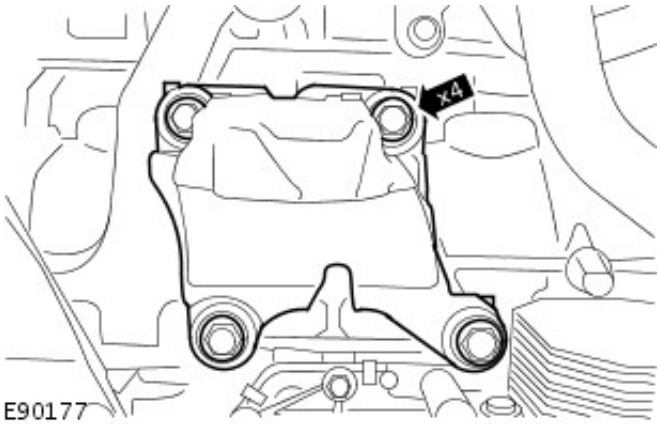
- Install a new O-ring seal.
- Install the clamp.
- Tighten the bolt to 22 Nm (16 lb.ft).



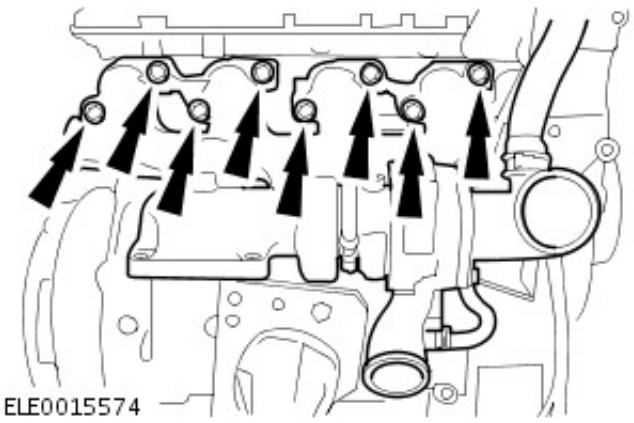
E44047

78. Install the RH engine mount bracket.

- Tighten the bolts to 63 Nm (46lb.ft).



E90177

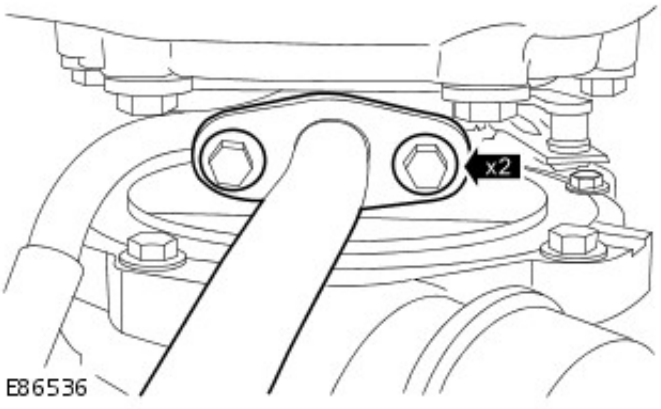


79. CAUTION: New nuts must be installed.

• NOTE: Clean the component mating faces.

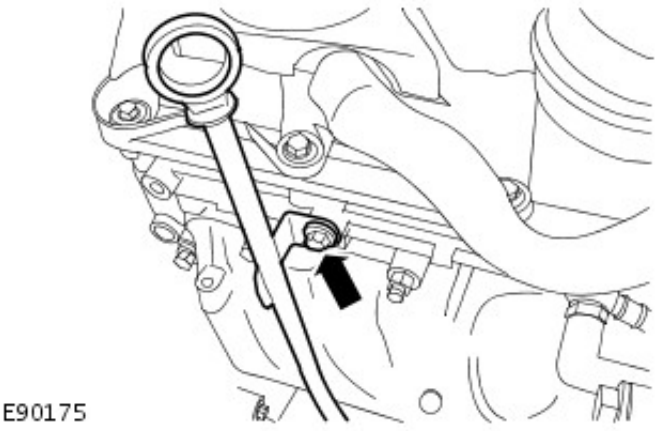
Install the exhaust manifold and turbocharger assembly.

- Install a new gasket.
- Tighten the nuts to 40 Nm (30 lb.ft).
- Tighten the bolts to 40 Nm (30 lb.ft).



80. Secure the turbocharger oil return pipe.

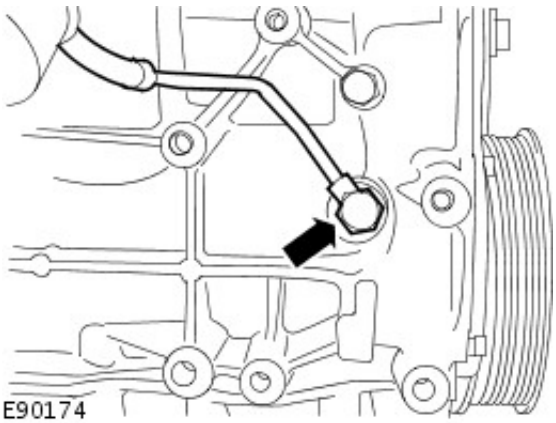
- Install a new gasket.
- Tighten the bolts to 10 Nm (7 lb.ft).



81. CAUTION: Remove and discard the blanking caps.

Install the oil level indicator and the oil level indicator tube.

- Install a new O-ring seal.
- Tighten the bolt to 10 Nm (7 lb.ft).
- Secure the wiring harness.



82. CAUTION: Remove and discard the blanking caps.

• NOTE: Clean the component mating faces.

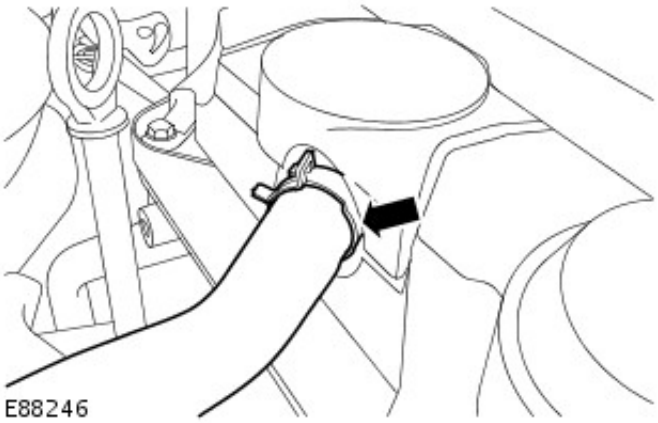
Connect the turbocharger oil feed pipe.

- Install new sealing washers.
- Tighten the banjo bolt to 35 Nm (26 lb.ft).

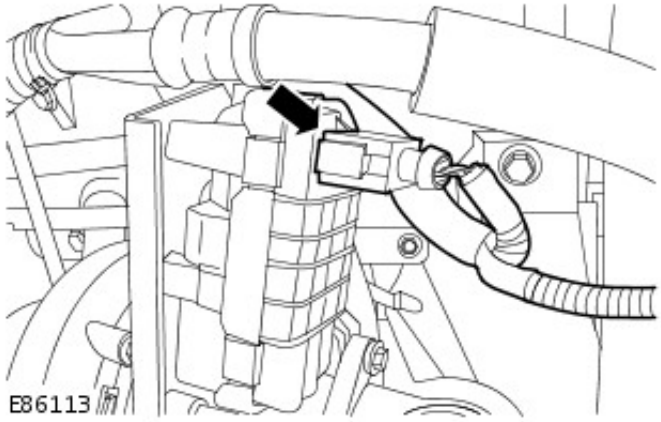
83. Connect the breather pipe

83. Connect the breather pipe.

- Secure with the clip.

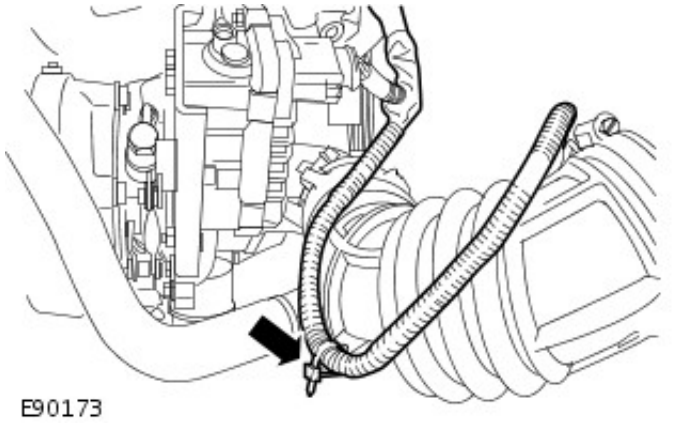


84. Connect the turbocharger actuator electrical connector.

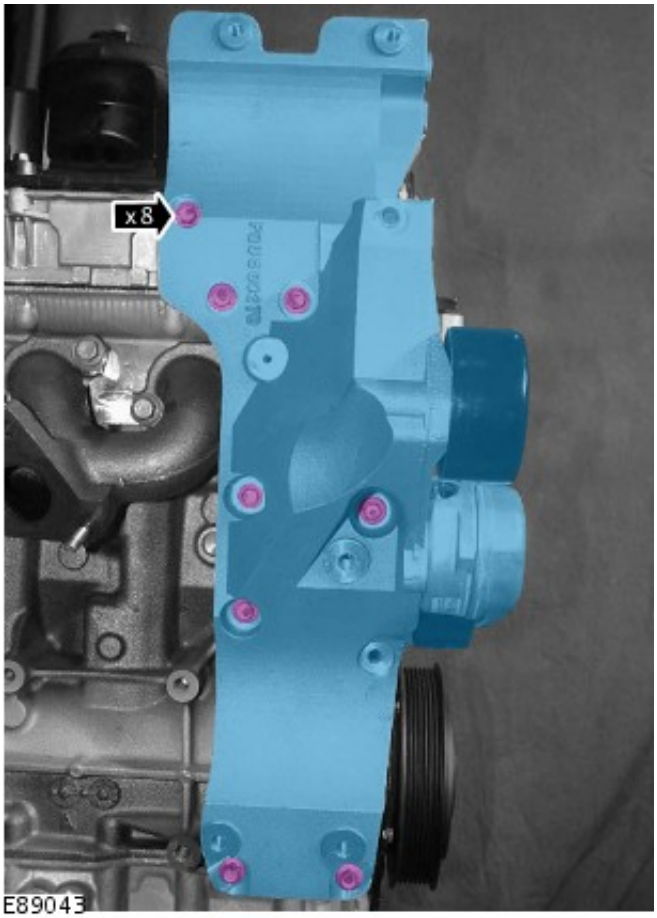


85. Secure the mass air flow (MAF) sensor wiring harness.

- Secure with a suitable tie strap.



86. Install the generator mounting bracket.



E89043

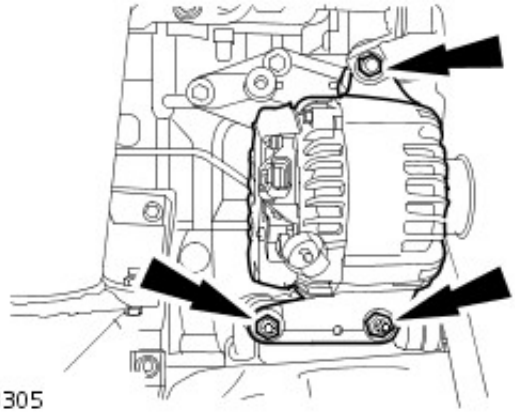
- Tighten the bolts to 25 Nm (18 lb.ft).

87. Install the turbocharger heat shield bracket.

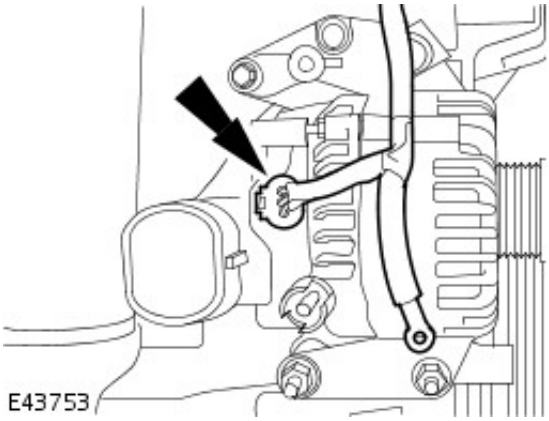
- Tighten the M6 bolt to 10 Nm (7 lb.ft).
- Tighten the M8 bolt to 20 Nm (15 lb.ft).

88. Install the generator.

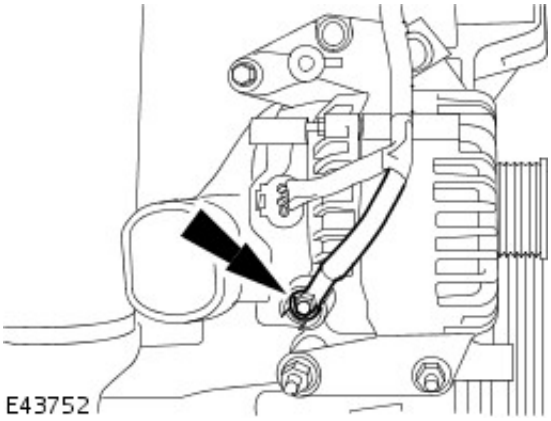
- Tighten the bolts to 48 Nm (35 lb.ft).


E48305

89. Connect the generator electrical connector.

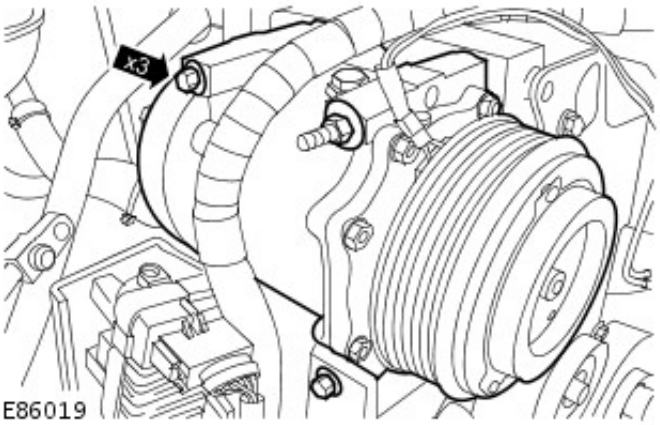

E43753

90. Connect the battery positive cable to the generator.



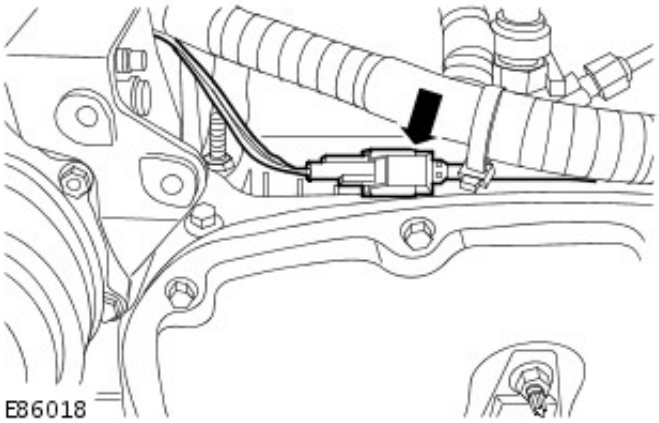
90. Connect the battery positive cable to the generator.

- Tighten the nut to 8 Nm (6 lb.ft).

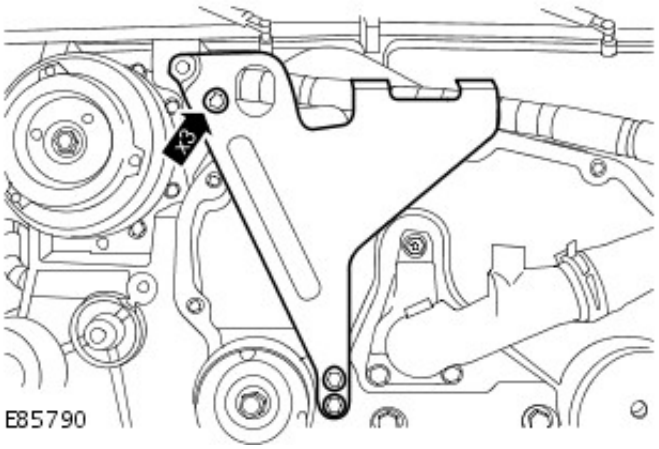


91. Install the air conditioning (A/C) compressor.

- Tighten the bolts to 22 Nm (16 lb.ft).



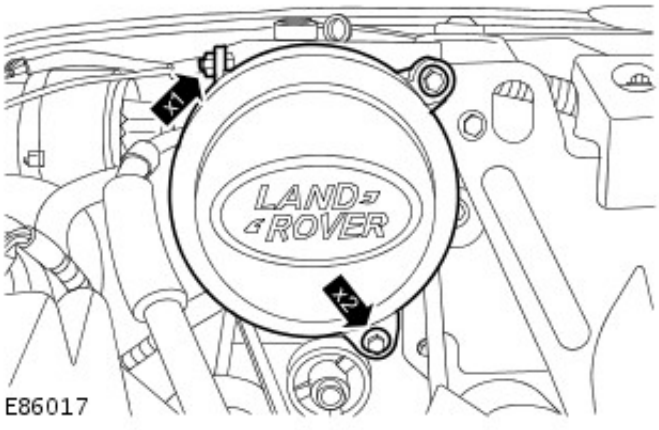
92. Connect the A/C compressor electrical connector.



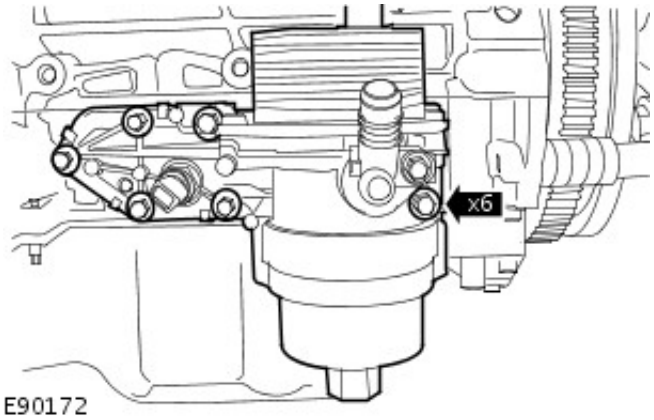
93. Install the engine lifting bracket.

- Tighten the bolts 10 Nm (7 lb.ft).

94. Install the A/C compressor pulley cover.



- Install the accessory drive belt to the A/C compressor pulley.
- Tighten the bolts 10 Nm (7 lb.ft).
- Tighten the nut 10 Nm (7 lb.ft).

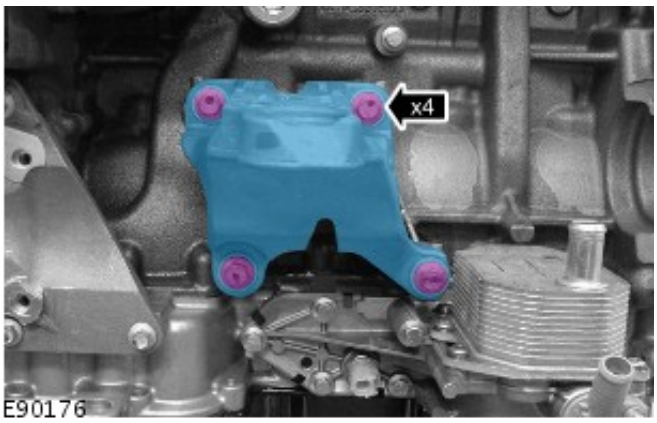


95. CAUTION: Remove and discard the blanking caps.

• NOTE: Clean the component mating faces.

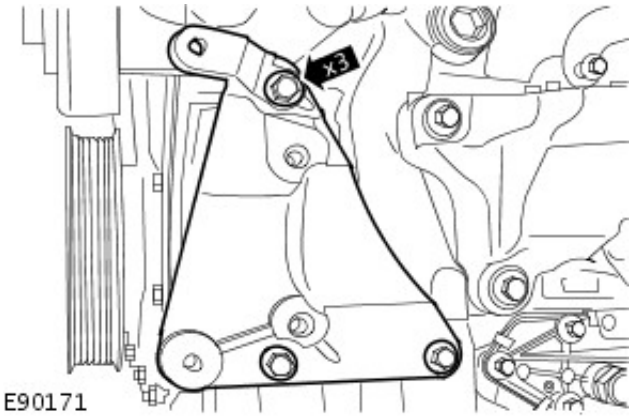
Install the oil filter housing assembly.

- Install a new gasket.
- Tighten the bolts to 23 Nm (17 lb.ft).



96. Install the LH engine mount bracket.

- Tighten the bolts to 63 Nm (46 lb.ft).

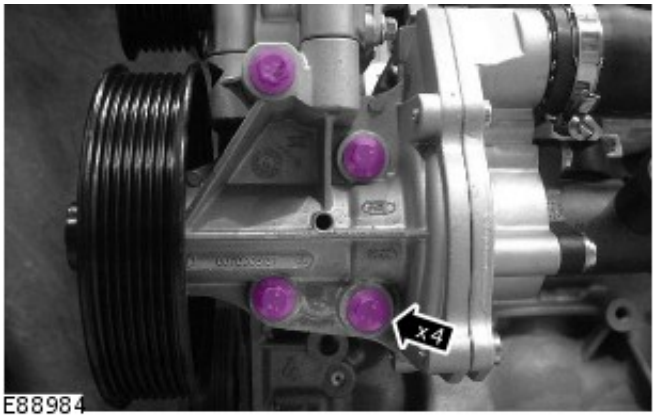


97. Install the power steering pump bracket.

- Tighten the bolts to 23 Nm (17 lb.ft).

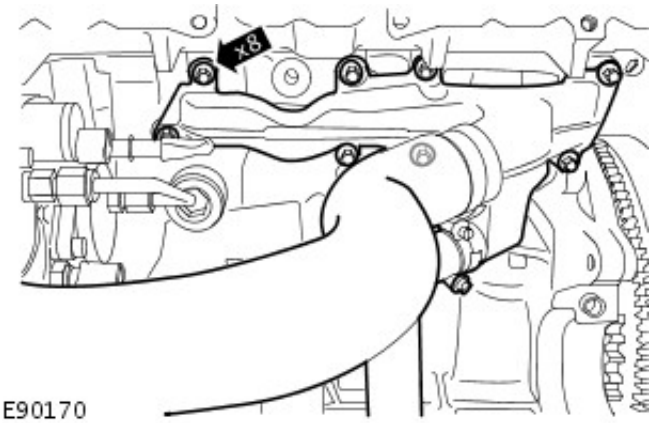
98. Install the coolant pump and coolant manifold assembly.

99. NOTE: Clean the component mating faces.



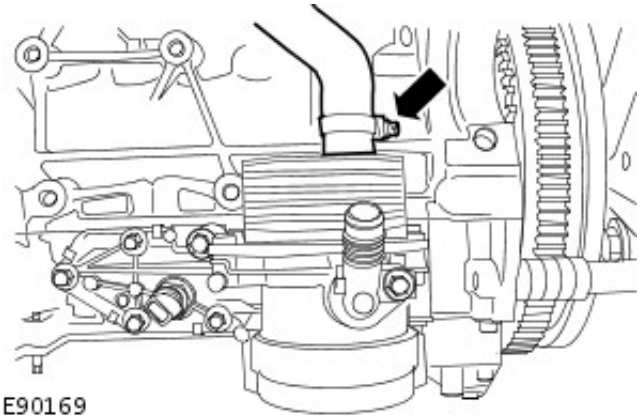
Secure the coolant pump.

- Install a new gasket.
- Tighten the bolts to 23 Nm (17 lb.ft).



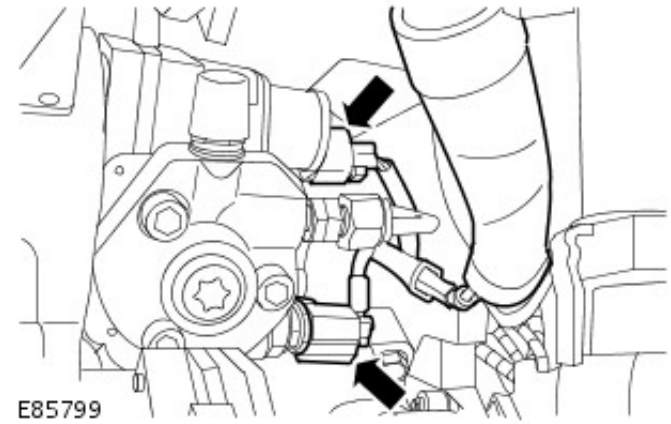
100. Secure the coolant manifold.

- Install a new gasket.
- Tighten the bolts 10 Nm (7 lb.ft).



101. Connect the coolant hose.

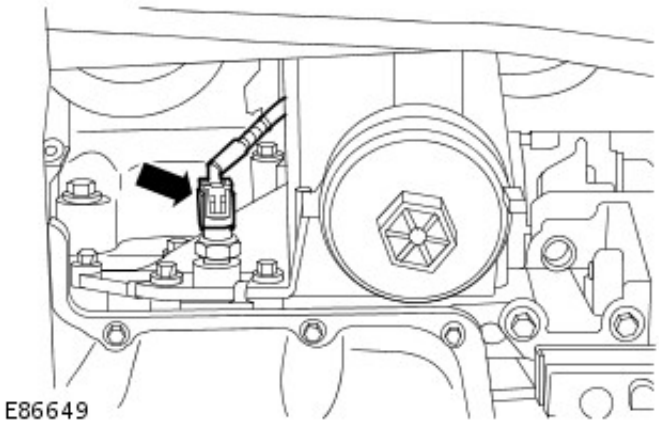
- Secure with the clip.



102. Connect the fuel metering valve and the fuel temperature sensor electrical connectors.

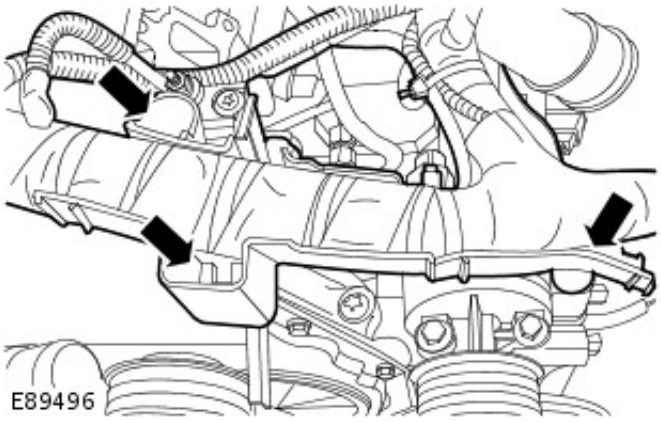
103. Connect the engine oil pressure (EOP) sensor electrical

103. Connect the engine oil pressure (EOP) sensor electrical connector.


E86649

104. Secure the engine wiring harness.

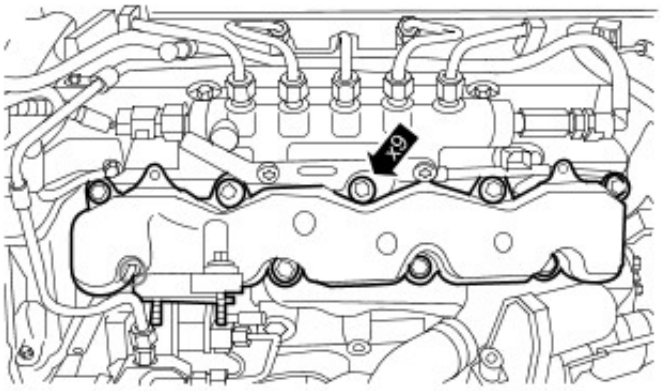
- Secure with the 3 clips.


E89496

105. NOTE: Clean the component mating faces.

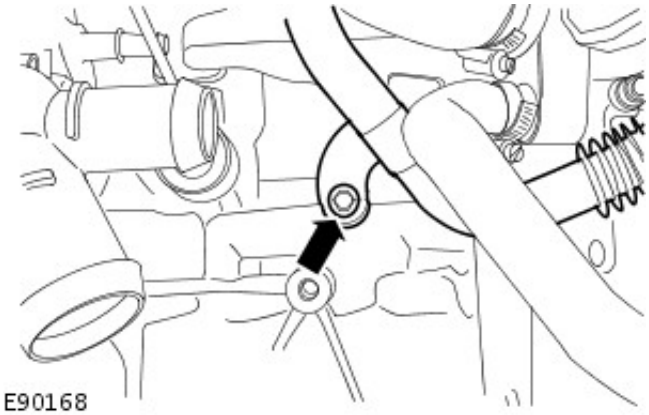
Install the exhaust gas recirculation (EGR) valve outlet tube and intake manifold assembly.

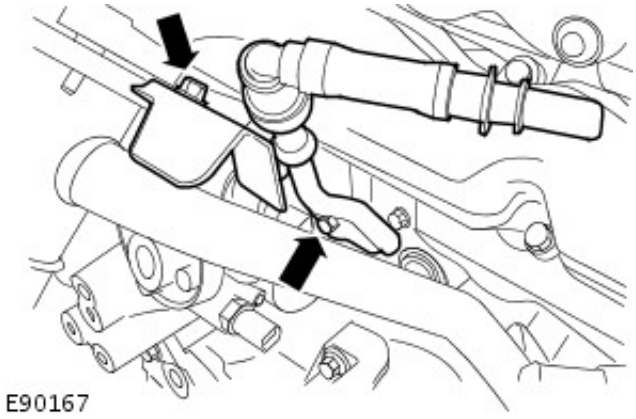
- Install new seals to the intake manifold.
- Tighten the bolts to 15 Nm (11 lb.ft).


E86529

106. Secure the EGR valve outlet tube.

- Tighten the bolt to 23 Nm (17 lb.ft).


E90168

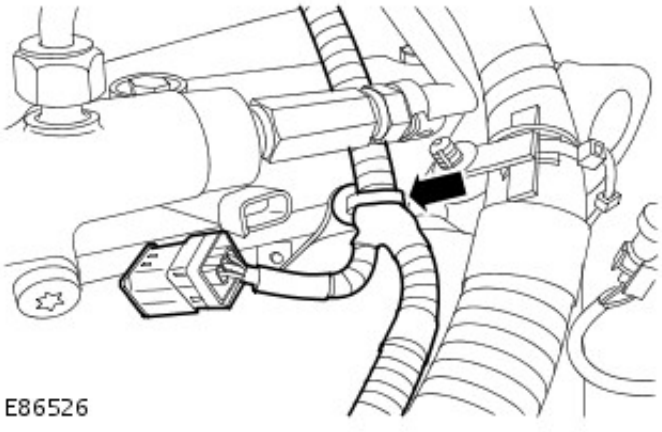

E90167

107. CAUTION: Remove and discard the blanking caps.

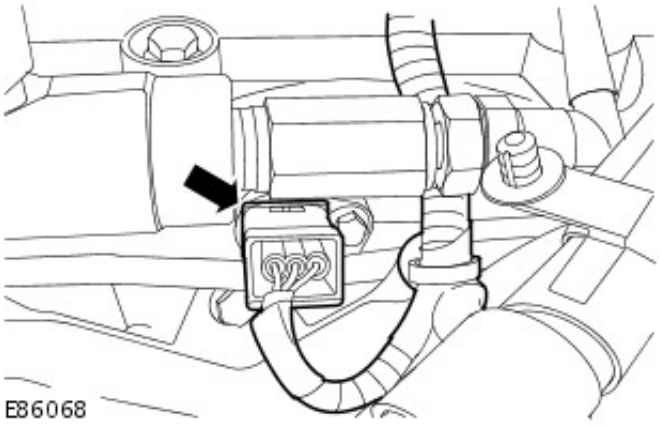
Install the fuel injection pump supply pipe.

- Tighten the bolt 7 Nm (5 lb.ft).

108. Secure the engine wiring harness.


E86526

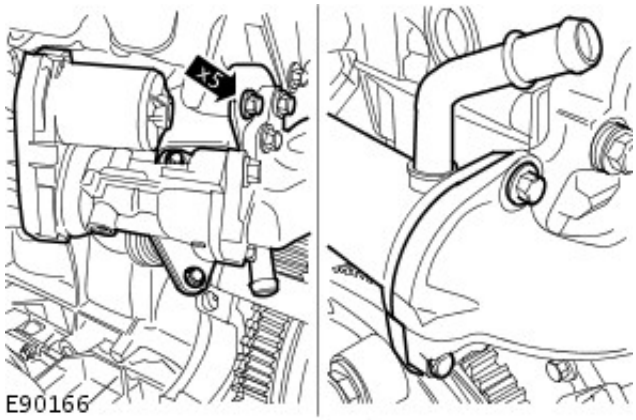
109. Connect the camshaft position (CMP) sensor electrical connector.


E86068

110. NOTE: Clean the component mating faces.

Install the EGR valve and the EGR cooler.

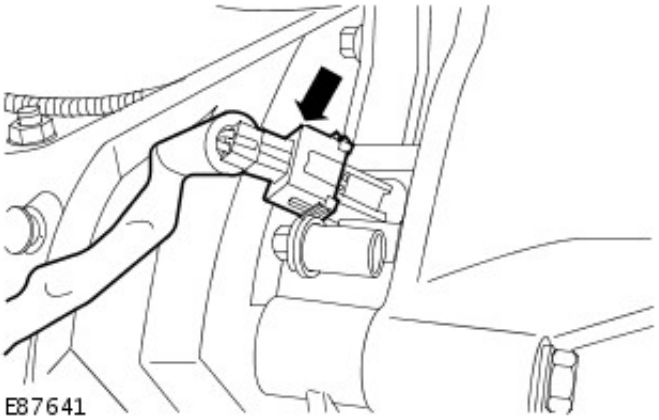
- Install new gaskets.
- Tighten the M8 bolts to 23 Nm (17 lb.ft).
- Tighten the M6 bolts to 10 Nm (7 lb.ft).
- Connect the EGR valve electrical connector.



E90166

111. Connect the CKP sensor electrical connector

111. Connect the CKP sensor electrical connector.



112. Remove the engine from the engine stand.

Installation

All vehicles

1. With assistance, carefully install the engine.
   - Clean the component mating faces.
2. Secure the engine to the transmission.
   - Tighten the bolts to 40 Nm (30 lb.ft).
   - Remove the hydraulic jack supporting the transmission.
3. Install the LH engine mount.
4. Install the RH engine mount.
5. Secure both of the engine mounts.
   - Lower the engine on to its mounts.
   - Tighten the bolts to 80 Nm (59 lb.ft).
   - Tighten the nuts to 80 Nm (59 lb.ft).
6. Connect the exhaust gas recirculation (EGR) cooler coolant hose.
   - Secure with the clip.
   - Secure the coolant hoses to EGR cooler.
7. Connect the heater coolant hose to the heater control valve.
   - Secure with the clip.
8. NOTE: Remove and discard the blanking caps.

   Connect the fuel lines.
   - Secure with the clip.
   - Secure the fuel return line in the clip.
9. Secure the power steering pump.
   - Remove and discard the tie-strap.
   - Tighten the bolts to 23 Nm (17 lb.ft).
10. Secure the accessory drive belt around the power steering pump pulley.
11. Connect the brake booster vacuum line to the brake vacuum pump.
12. Connect the coolant hoses to the coolant pump housing.
    - Secure with the clips.
13. Connect the radiator upper coolant hose.
    - Secure with the clip.
14. Secure the engine wiring harness.
    - Connect the engine control module (ECM) electrical connectors.
    - Secure in the clips.
15. Connect the glow plug electrical connector.
16. Connect the engine wiring harness electrical connector.

17. Install the charge air cooler outlet hose.
    - Tighten the clips.
18. Install the charge air cooler inlet hose.
    - Tighten the clips.

Vehicles with air conditioning

19. NOTE: Remove and discard the blanking caps.

    Connect the air conditioning (A/C) compressor high-pressure line.
    - Install new O-ring seals.

All vehicles

20. Install the air cleaner.
    For additional information, refer to: Air Cleaner (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
21. Connect the coolant hose to the EGR cooler.
    - Secure with the clip.
22. Connect the coolant hose to the engine oil cooler.
    - Secure with the clip.
23. Connect the reverse light switch electrical connector.
24. Secure the crankshaft position (CKP) sensor and reverse light switch wiring harness to the transmission.
    - Secure the clips.
25. Install the starter motor.
    For additional information, refer to: Starter Motor (303-06 Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
26. Install the catalytic converter.
    For additional information, refer to: Catalytic Converter (309-00 Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
27. Install the cooling fan shroud.
    For additional information, refer to: Cooling Fan Shroud (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
28. Connect the battery ground cable.
    For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).
29. Install the hood.
    For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Item	Specification
Anti-freeze	WAS-M97B44-D
Anti-freeze concentration - Will provide frost protection to -40°C (-40°F)	50%
Specific gravity of coolant at 20°C (68°F), to protect against frost down to -40°C (-40°F)	1.068

Item	Capacity
Cooling System	10 Liters (17.6 pints) (10.6 quarts)
Radiator	2.3 Liters (4 pints) (2.4 quarts)
Coolant Expansion Tank (To Cold Level)	1.2 Liters (2.1 pints) (1.3 quarts)

Item	Description
Cooling system type	Pressurized, thermostatically controlled with coolant expansion tank
Radiator	Cross flow
Coolant expansion tank	Remote with cold level fill mark
Pressure cap rating	100 kPa (1 bar) (15.9 lbf/in²)
Thermostat: Starts to open	82° C (180°F)
Thermostat: Fully open	96° C (205°F)
Cooling fan	Viscous
Cooling fan control	Bi-metallic
Cooling fan diameter	475 mm (18.70 inches)
Cooling fan direction of rotation	Clockwise when viewed from front of engine
Coolant pump	Centrifugal flow impeller, belt driven from the crankshaft

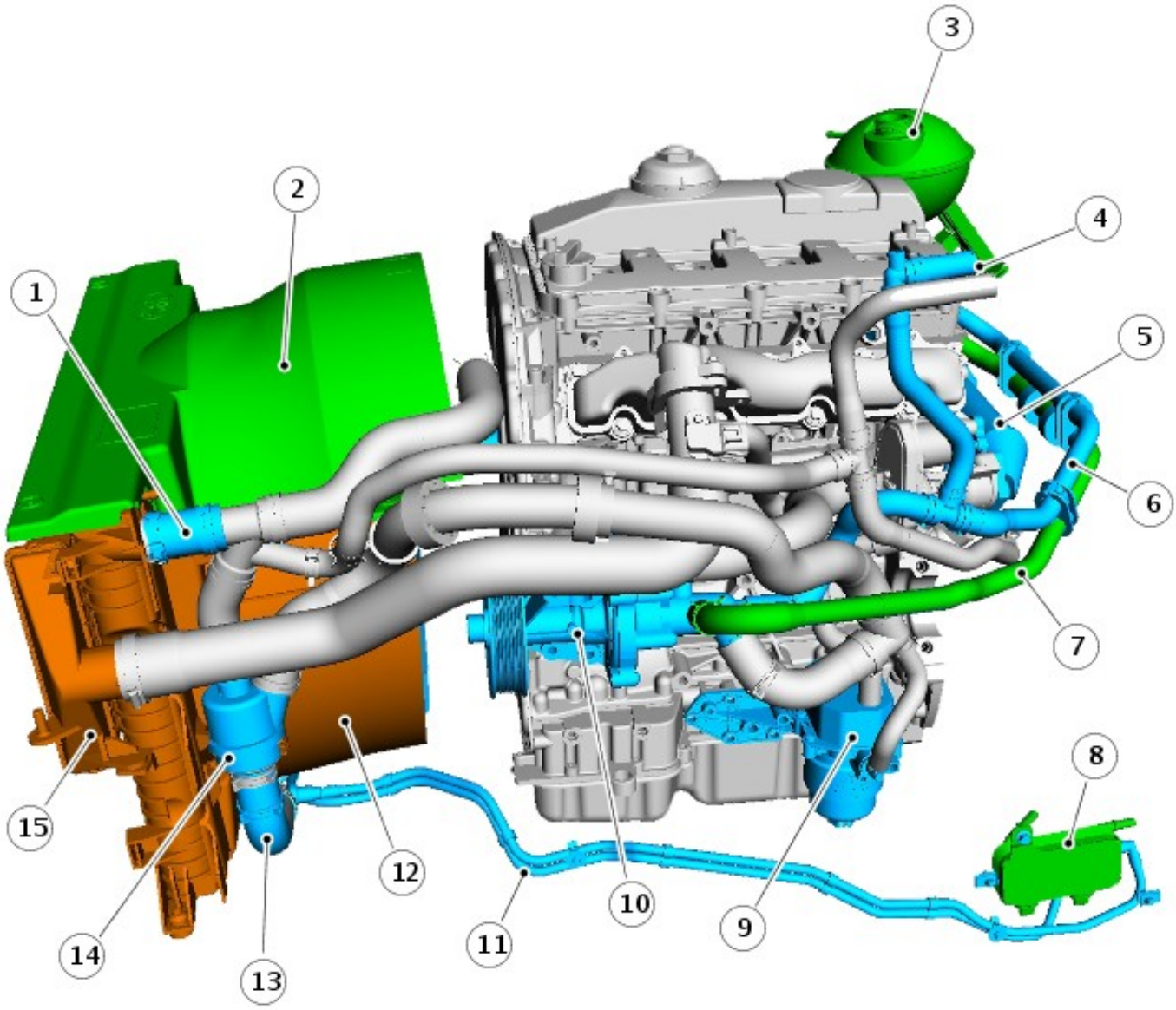
Torque Specifications

Description	Nm	lb-ft
Heater hose air bleed screw	2	1
Coolant pump bolts	23	17
Coolant pump outlet manifold	10	7
Coolant pump hose clip	3	2
Viscous coupling bolts	10	7
Expansion tank bolt	10	7
Charge air cooler to radiator bolts	20	15
Charge air cooler inlet and outlet hose clips	3	2
Charge air cooler bracket bolts	9	7
Power steering reservoir nuts	4	3

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Cooling

Description and Operation

COMPONENT LOCATION



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Item	Part Number	Description
1	-	Radiator top hose
2	-	Cooling fan top cowl
3	-	Expansion tank
4	-	Passenger compartment heater connections
5	-	Exhaust Gas Recirculation (EGR) cooler
6	-	EGR cooler outlet hose
7	-	Expansion tank hose
8	-	Fuel cooler
9	-	Engine oil cooler
10	-	Coolant pump
11	-	Fuel cooler feed and return hoses

12	-	Cooling fan lower cowl
13	-	Radiator bottom hose
14	-	Thermostat assembly
15	-	Intercooler

OVERVIEW

The cooling system employed is the bypass type, which allows coolant to circulate around the engine and the heater circuit while the thermostat is closed. The primary function of the cooling system is to maintain the engine within an optimum temperature range under changing ambient and engine operating conditions. Secondary functions are to provide heating for the passenger compartment and cooling for the Exhaust Gas Recirculation (EGR) system.

The cooling system comprises:

- A radiator
- A passenger compartment heater matrix
- An EGR cooler
- A coolant pump
- An expansion tank
- A cooling fan
- Connecting hoses and pipes

The coolant is circulated by a centrifugal type pump mounted on the front Left Hand (LH) side of the engine and driven by the ancillary drive 'polyvee' belt. The coolant pump circulates coolant around the cylinder block and cylinder head, to the radiator, heater matrix and the EGR cooler, via the coolant hoses.

The thermostat is located in the bottom hose assembly on the inlet side of the cooling circuit and provides a stable control of the coolant temperature in the engine.

The radiator is a cross flow type with an aluminium matrix and moulded plastic end tanks. The radiator end tanks have brackets which allow for the attachment of the fan cowl assembly, intercooler and, if fitted, air conditioning system condenser. The bottom of the radiator is located in rubber bushes supported by brackets on the chassis longitudinals. The top of the radiator is located in rubber bushes secured by brackets fitted to the bonnet locking platform.

An air-to-air intercooler is located in front of the radiator and is used to cool the compressed air from the turbocharger before it enters the inlet side of the engine.
For additional information, refer to: Intake Air Distribution and Filtering (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

The radiator top hose is connected to a coolant outlet elbow, which is bolted to the cylinder head. The top hose also has a connection for the feed to the heater matrix. The radiator bottom hose is routed around the front of the engine and is connected to the thermostat assembly. The bottom hose also has a return connection from the fuel cooler. The feed for the fuel cooler comes from a connection just below the bottom hose connection on the Right Hand (RH) side of the radiator assembly.

An expansion tank is fitted to the RH suspension turret in the engine compartment. The expansion tank allows for expansion of the coolant when the engine is hot and replaces the coolant into the system as the engine cools down.

The EGR cooler is located in the coolant return line from the engine and top hose. The fluid cools the exhaust gases returning to the inlet manifold, which improves emissions.

The heater matrix outlet hose incorporates a bleed screw to bleed air when filling the cooling system.

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Cooling

Diagnosis and Testing

Overview

For information on the operation of the systems:
REFER to: Engine Cooling (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

1. **1.** Verify the customer concern.
2. **2.** Visually inspect for obvious mechanical or electrical faults.

Visual Inspection Chart

Mechanical	Electrical
• Coolant leaks • Coolant hoses • Coolant expansion tank • Radiator • Heater core • Accessory drive belt • Viscous fan	• Fuses - Fuse 29, passenger compartment • Harnesses • Loose or corroded connector(s) • Cylinder head temperature (CHT) sensor • Engine oil temperature (EOT) sensor

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible cause	Action
Coolant loss	• Hoses • Hose connections • Radiator • Water pump • Heater core • Gaskets • Engine casting cracks • Engine block core plugs	Carry out a visual inspection. If there are no obvious leaks, carry out a pressure test using your workshop tester. Rectify as necessary.
Overheating	• Low/contaminated coolant • Thermostat • Viscous fan • Cylinder head temperature (CHT) sensor • Restricted air flow over the radiator	Check the coolant level and condition. Carry out a pressure test using your workshop tester. Rectify as necessary. Check the thermostat and rectify as necessary. Check the viscous fan operation, make sure the viscous fan rotates freely. Check for obstructions to the air flow over the radiator. Rectify as necessary.
Engine not reaching normal temperature	• Thermostat • Viscous fan • Electric fan	Check the thermostat operation. Check the viscous fan operation, make sure the viscous fan is not seized. Rectify as necessary.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible causes	Action
P01152F	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - signal erratic	• CHT sensor circuit: short circuit to power • CHT sensor circuit: short circuit to ground • CHT sensor circuit: open circuit • CHT sensor fault	Check the CHT sensor and circuit. Refer to the electrical guides. Install a new CHT sensor if necessary. REFER to: Cylinder Head Temperature (CHT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011516	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - circuit voltage below threshold	• CHT sensor circuit: short circuit to ground • CHT sensor circuit: open circuit • CHT sensor fault	
P011517	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - circuit voltage above threshold	• CHT sensor circuit: short circuit to power • CHT sensor fault	
P048000	Fan 1 control circuit on/off	• Cooling fan control circuit: short circuit to ground • Cooling fan control circuit: short circuit to power • Cooling fan control circuit:	Check the cooling fan and circuits. Refer to the electrical guides. Install a new cooling fan if necessary. REFER to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

		open circuit • Cooling fan fault	

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cooling System Draining, Filling and Bleeding

General Procedures

WARNING: Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

• CAUTIONS:

The engine cooling system must be maintained with the correct concentration and type of anti-freeze solution to prevent corrosion and frost damage. Failure to follow this instruction may result in damage to the engine.

Engine coolant will damage the paint finished surfaces. If spilt, immediately remove the coolant and clean the area with water.

1. Set the heater controls to Hot.

2. WARNING: Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

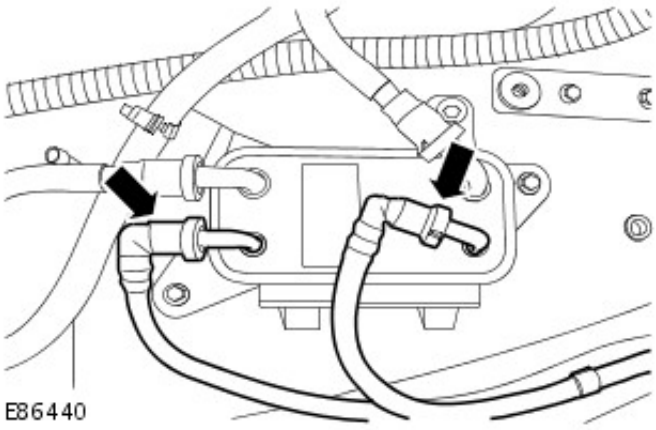
Remove the coolant expansion tank cap.

3. WARNING: Since injury such as scalding could be caused by escaping steam or coolant, do not remove the cooling system bleed screw while the system is hot.

Loosen the cooling system bleed screw.

4. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.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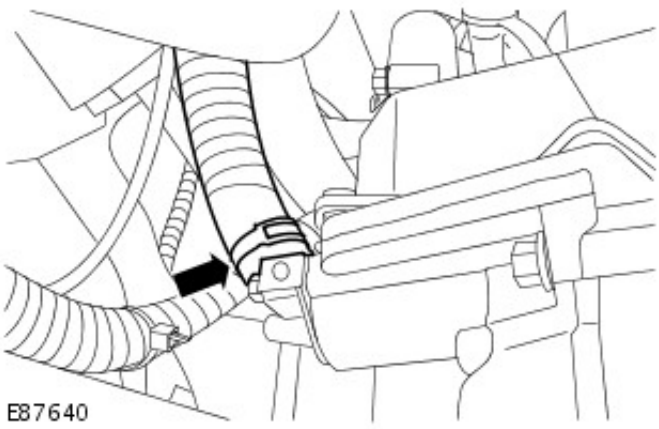
5. WARNING: Eye protection must be worn.

• NOTE: Position a container to collect the coolant.

Disconnect the 2 fuel cooler coolant pipes.

- Allow the coolant to drain.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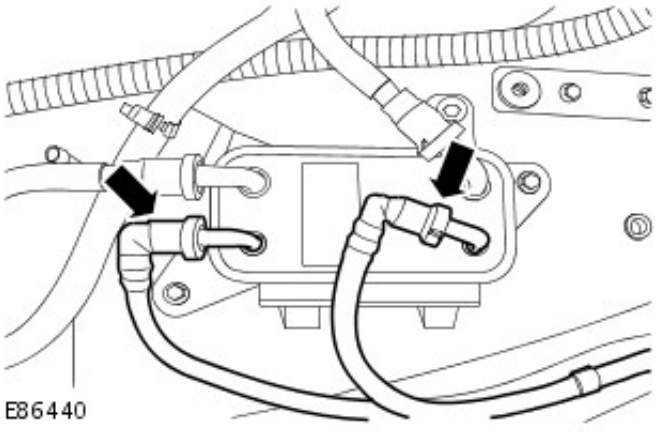
6. WARNING: Eye protection must be worn.

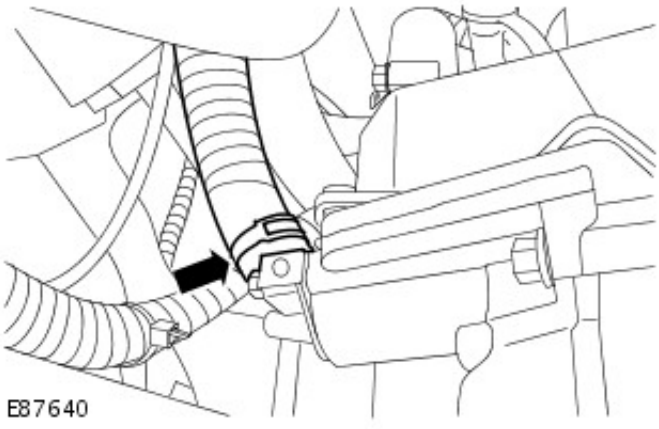
Disconnect the oil thermostat coolant hose.

- Allow the coolant to drain.

7. Remove the container.



8. Connect the 2 fuel cooler coolant pipes.



9. Connect the oil thermostat coolant hose.

10. CAUTIONS:

Engine coolant will damage the paint finished surfaces. If spilt, immediately remove the coolant and clean the area with water.

Anti-freeze concentration must be maintained at 50%.

Fill the cooling system expansion tank until the coolant level becomes static with in the "COLD FILL RANGE".

11. Tighten the cooling system bleed screw.

12. Install the coolant expansion tank cap.

13. CAUTIONS:

Make sure the coolant level remains above the "COLD FILL RANGE" lower level mark.

Observe the engine temperature gauge. If the engine starts to over-heat switch off immediately and allow to cool. Failure to follow this instruction may cause damage to the vehicle.

Start and run the engine.

- Hold the engine speed at 3,000 RPM for one minute.
- Return the engine to idle for five minutes.
- Hold the engine speed at 3,000 RPM for one minute.
- Run the engine until the thermostat opens.

14. WARNING: Release the cooling system pressure by slowly turning the coolant expansion tank cap a quarter of a turn. Cover the expansion tank cap with a thick cloth to prevent the possibility of scalding. Failure to follow this instruction may

result in personal injury.

• NOTE: When the coolant bleed is complete and prior to installing the expansion tank cap, top-up the expansion tank to 30mm above the maximum level.

Switch the engine off.

- Remove the coolant expansion cap, allow the level to settle and top-up so that the level is 30mm above the upper level.
- Allow the engine to cool.

15. Clean any spilt coolant from the vehicle.

16. Check and top-up the coolant if required.

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cooling System Draining and Vacuum Filling

General Procedures

WARNING: To avoid having scalding hot coolant or steam blowing out of the cooling system, use extreme care when removing the coolant pressure cap from a hot cooling system. Wait until the engine has cooled, then wrap a thick cloth around the coolant pressure cap and turn it slowly until the pressure begins to release. Step back while the pressure is released from the system. When certain all the pressure has been released (still with a cloth) turn and remove the coolant pressure cap from the coolant expansion tank. Failure to follow these instructions may result in personal injury.

- CAUTIONS:

The engine cooling system must be maintained with the correct concentration and type of anti-freeze solution to prevent corrosion and frost damage. Failure to follow this instruction may result in damage to the vehicle.

Engine coolant will damage paint finished surfaces. If spilled, immediately remove coolant and clean area with water.

1. Set the heater controls to maximum HOT.

2. Remove the hood.
For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

3. WARNING: Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

Remove coolant expansion tank filler cap.

4. Loosen the cooling system bleed screw.

5. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

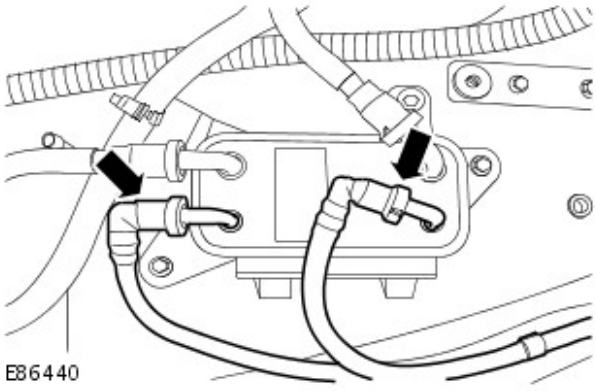
Raise and support the vehicle.

6. WARNING: Eye protection must be worn.

Position container to collect coolant.

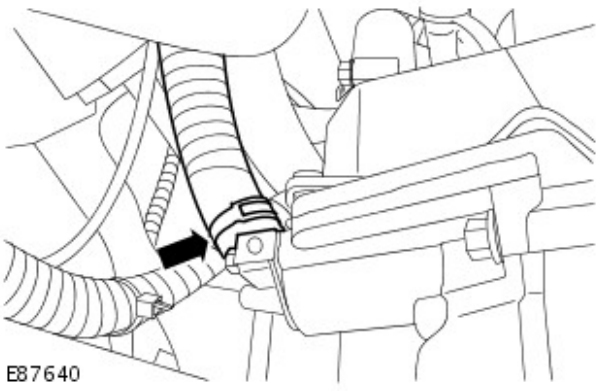
7. Disconnect the 2 fuel cooler coolant pipes.

- Allow the coolant to drain.

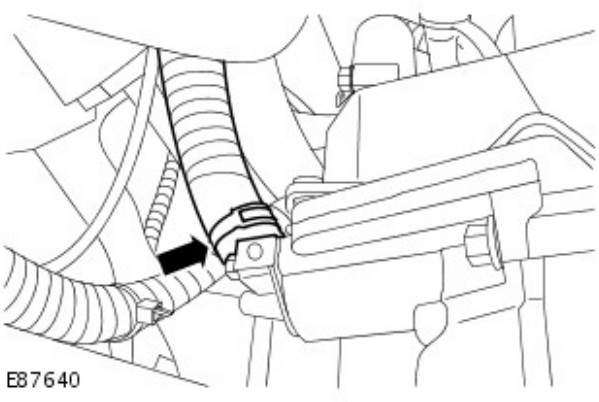

E86440

8. Disconnect the coolant hose from the engine oil cooler.

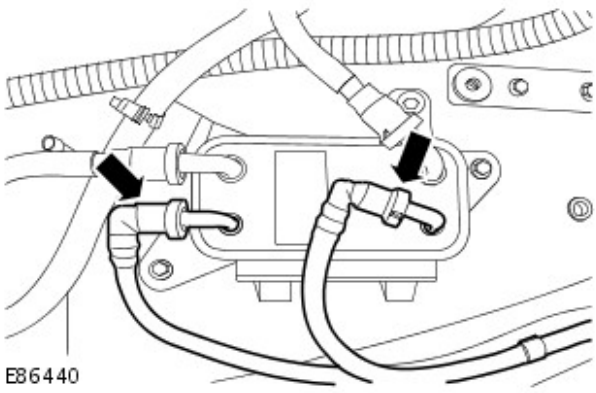
- Release the clip.
- Allow the coolant to drain.


E87640

9. Connect coolant hose to engine oil cooler.



- Install the clip.



10. Connect the 2 fuel cooler coolant pipes.

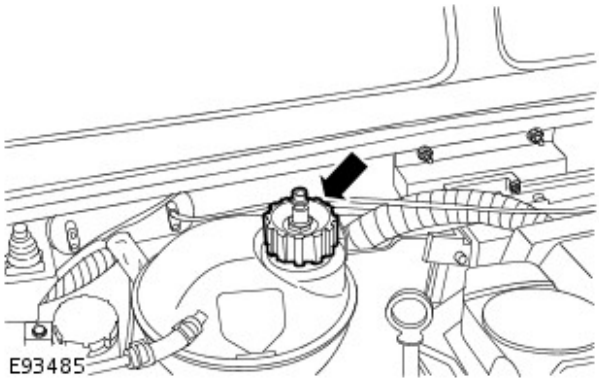
- Remove the container.

11. Tighten the cooling system bleed screw.

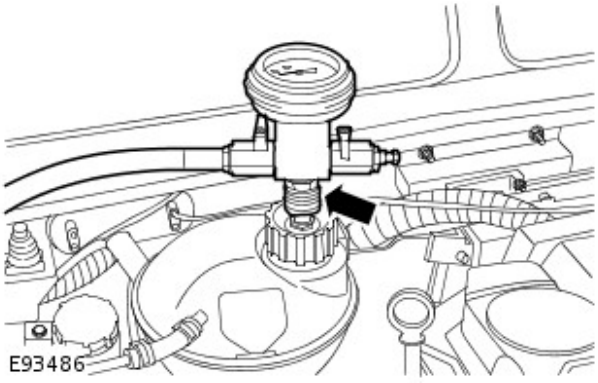
12. CAUTION: The engine cooling system must be maintained with the correct concentration and type of anti-freeze solution to prevent corrosion and frost damage. Failure to follow this instruction may result in damage to the vehicle.

Prepare a sufficient amount of coolant to the required concentration and transfer to a container.

13. Install the cooling system vacuum refill adaptor to the expansion tank.

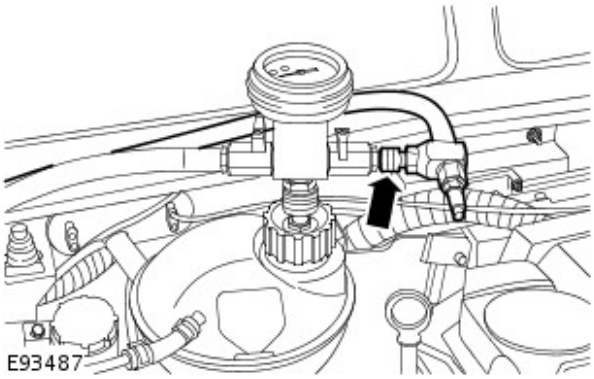


14. Install the vacuum filler gauge to the cooling system vacuum refill adaptor.



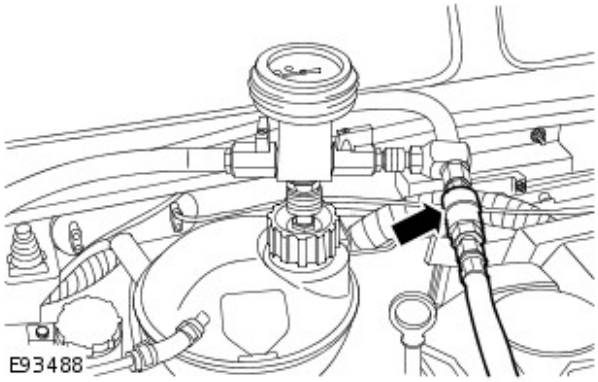
15. Install the venturi tube assembly to the vacuum filler

gauge.



16. NOTE: Make sure both valves on gauge assembly are in the closed position.

Connect a regulated compressed air supply to the venturi tube assembly.



17. NOTE: Make sure air cannot enter the hose.

Position the coolant pick-up pipe into a container of clean coolant.

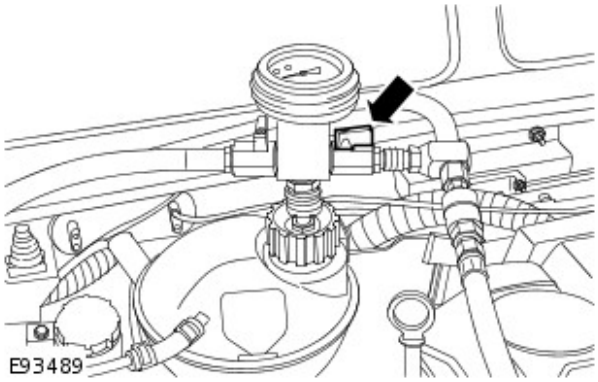
18. Position the evacuated air hose into a container.

19. NOTE: Make sure the coolant supply valve is in the closed position on the vacuum filler gauge assembly.

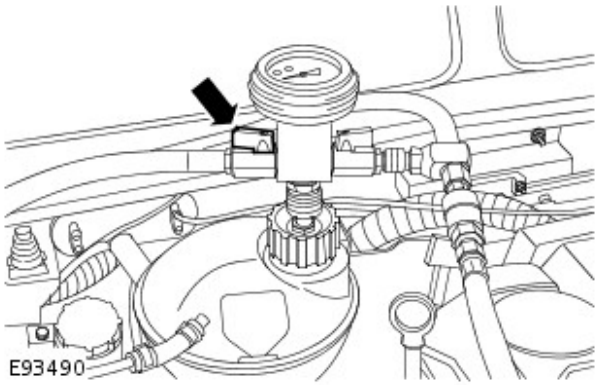
• NOTE: The coolant vacuum fill tool needs an air pressure of 6 to 8 bar (87 to 116 psi) to operate correctly.

• NOTE: Small diameter or long airlines may restrict airflow to the coolant vacuum fill tool.

Open air supply valve.

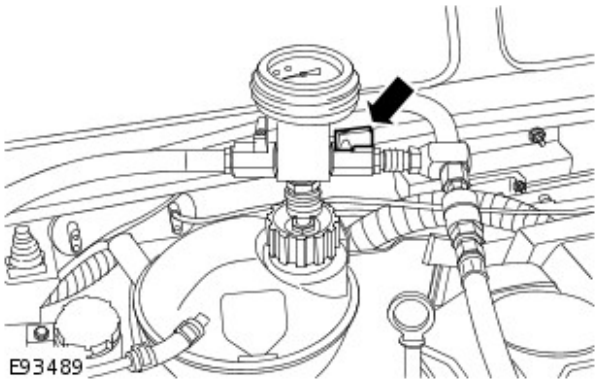


20. Open coolant supply valve for 2 seconds to prime coolant supply hose.

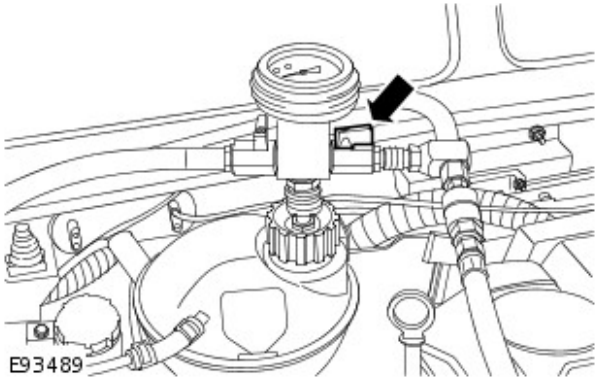


21. Apply air pressure progressively until the arrow on the

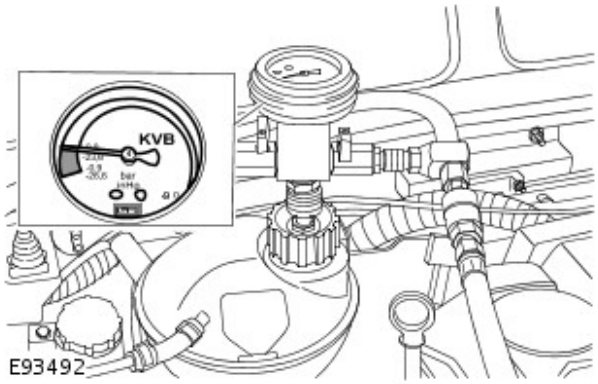
vacuum filler gauge reaches the green segment.



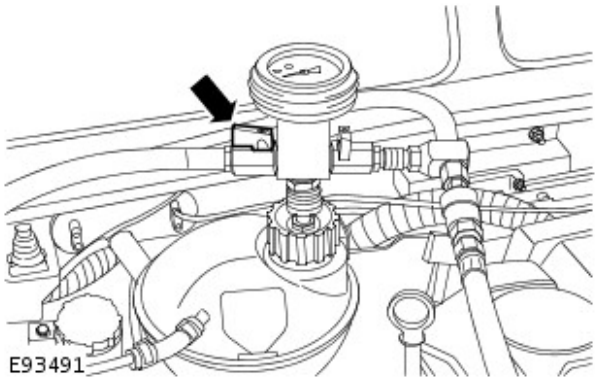
22. Close air supply valve and disconnect air supply.



23. Allow 1 minute to check vacuum is held.



24. Open coolant supply valve and allow coolant to be drawn into system.



25. When expansion tank is full and coolant movement has ceased close coolant supply valve.

26. Remove vacuum refill adaptor and gauge from expansion tank.

27. Install the coolant expansion tank filler cap.

28. Install the hood.
For additional information, refer to: Hood (501-02 Front End Body Panels, Removal and Installation).

29. CAUTIONS:

- Make sure the coolant level remains above the "COLD

FILL RANGE" lower level mark.

Observe the engine temperature gauge. If the engine starts to over-heat switch off immediately and allow to cool. Failure to follow this instruction may cause damage to the vehicle.

Start and run engine.

- Hold the engine speed at 3,000 RPM for one minute.
- Return the engine to idle for five minutes.
- Hold the engine speed at 3,000 RPM for one minute.
- Run the engine until normal operating temperature is reached.

30. Switch off the engine and allow to cool.

31. WARNING: Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

Check and top-up the coolant level if required.

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Coolant Expansion Tank

Removal and Installation

Removal

1. WARNINGS:

Release the cooling system pressure by slowly turning the coolant expansion tank cap a quarter of a turn. Cover the expansion tank cap with a thick cloth to prevent the possibility of scalding. Failure to follow this instruction may result in personal injury.

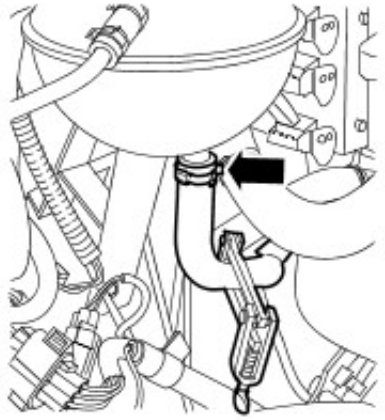
Since injury such as scalding could be caused by escaping steam or coolant, do not remove the filler cap from the coolant expansion tank while the system is hot.

CAUTION: Engine coolant will damage the paint finished surfaces. If spilt, immediately remove the coolant and clean the area with water.

Release the cooling system pressure.

2. Disconnect the coolant hose.

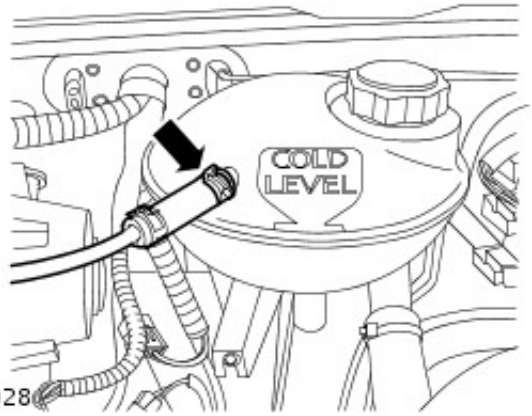
- Clamp the hose to minimize coolant loss.
- Position a container to collect the fluid spillage.
- Release the clip.



E90027

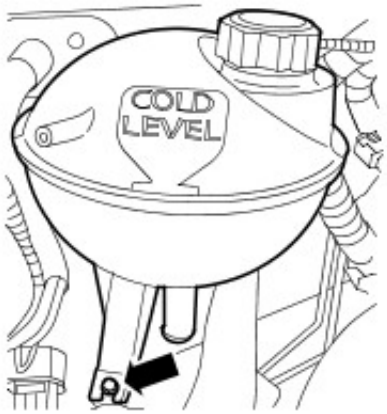
3. Disconnect the radiator bleed hose.

- Release the clip.



E90028

4. Remove the coolant expansion tank.



E90029

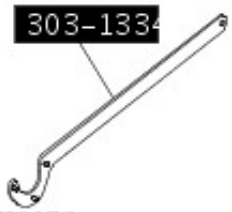
1. Remove the coolant expansion tank.
   - Remove the bolt.

Installation

1. Install the coolant expansion tank.
   - Tighten the bolt to 10 Nm (7 lb.ft).
2. Connect the radiator bleed hose.
   - Secure with the clip.
3. Connect the coolant hose.
   - Secure with the clip.
   - Remove the hose clamp.
4. Check and top up the coolant.
   - Remove the container.

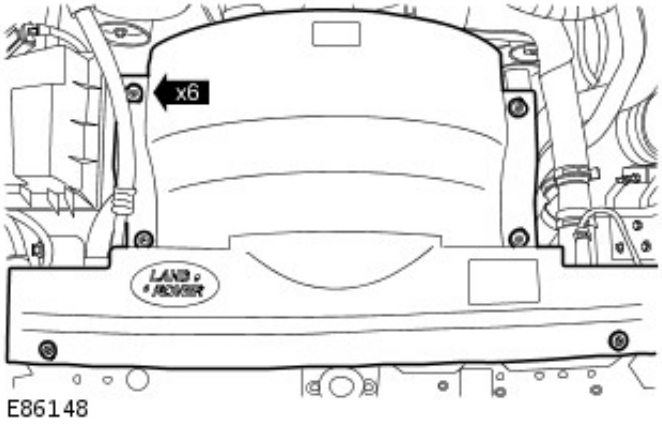
Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cooling Fan

Removal and Installation

Special Tool(s)	
E46076	303-1142 Cooling fan spanner
 E91076	303-1334 Cooling fan retaining tool

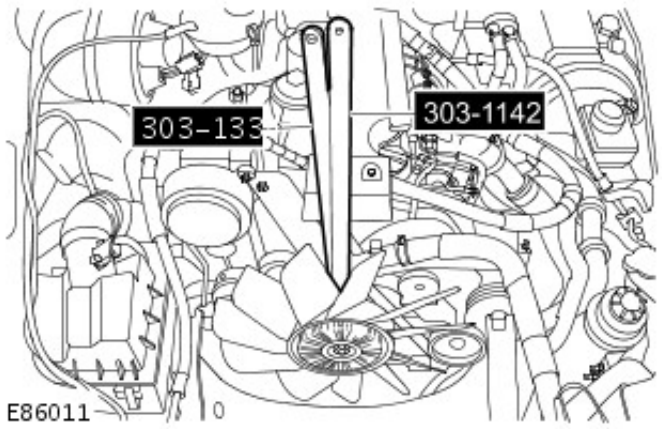
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the cooling fan upper shroud.
   - Release the 6 clips.



E86148

3. Using the special tools, remove the cooling fan.



E86011

4. NOTE: Do not disassemble further if the component is

removed for access only.

Remove the viscous coupling.

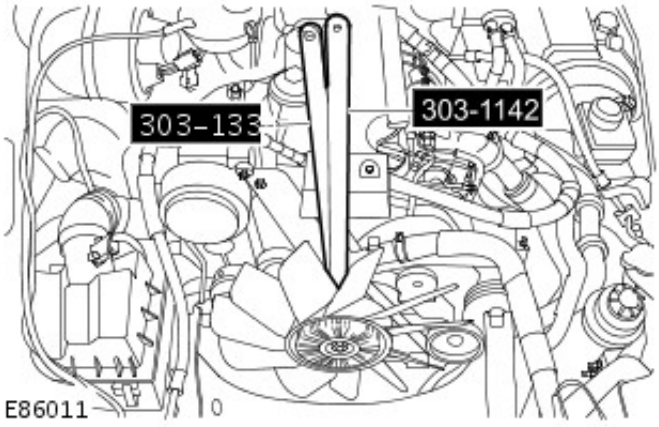
- Remove the 4 bolts.

Installation

1. Install the viscous coupling.

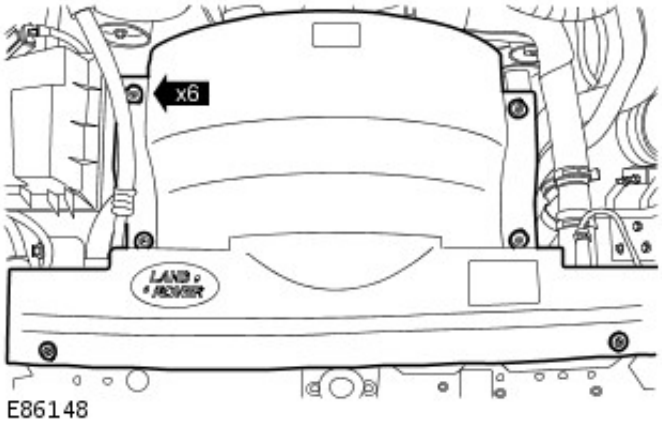
- Clean the component mating faces.
- Tighten the bolts to 10 Nm (7 lb.ft).

2. Using the special tools, install the cooling fan.



3. Install the cooling fan upper shroud.

- Secure the 6 clips.



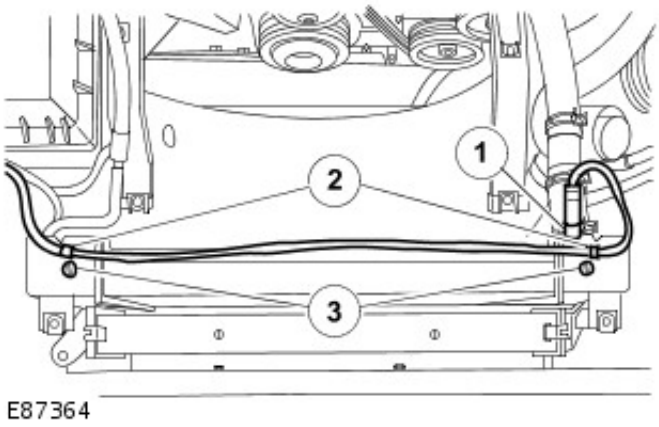
4. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cooling Fan Shroud

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Drain the cooling system.
   For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
3. Remove the cooling fan.
   For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

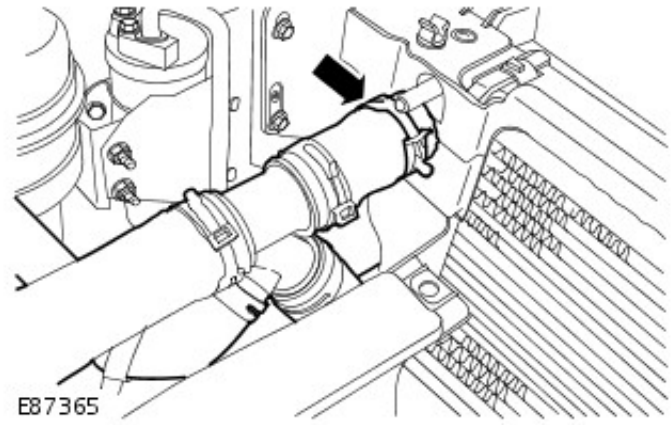


E87364

4. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Release the cooling fan shroud.

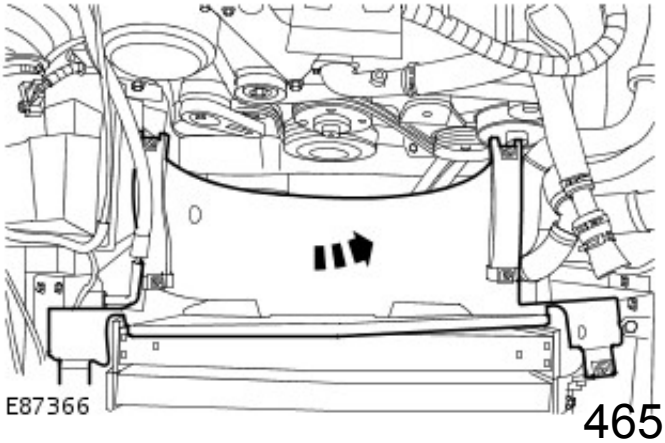
   1. Disconnect the coolant expansion tank hose.
   2. Release the coolant expansion tank hose from the cooling fan shroud.
   3. Release the cooling fan shroud remove the 2 screws.


E87365

5. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Disconnect the radiator top hose.

6. Release the thermostat from the cooling fan shroud.
7. Remove the cooling fan shroud.


E87366

Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Coolant Pump

Removal and Installation

Removal

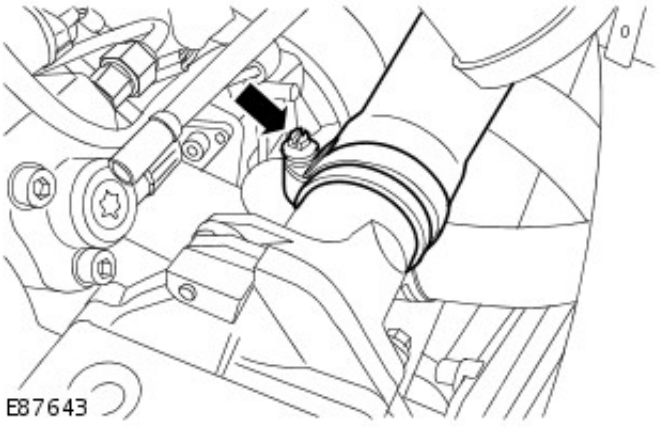
1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

3. Drain the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

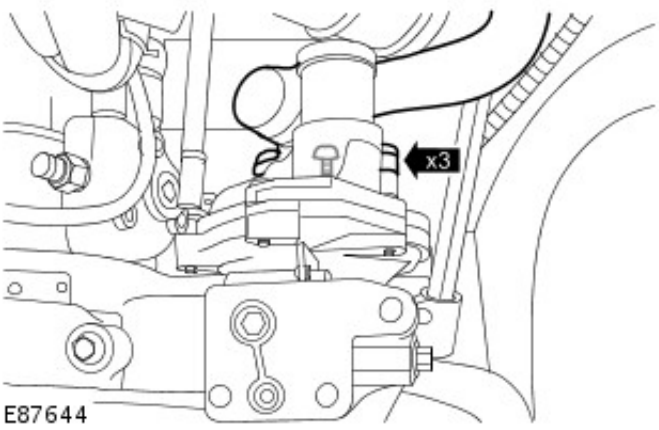
4. Remove the brake vacuum pump.
For additional information, refer to: Brake Vacuum Pump (206-07 Power Brake Actuation, Removal and Installation).



5. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the coolant hose from the coolant pump.

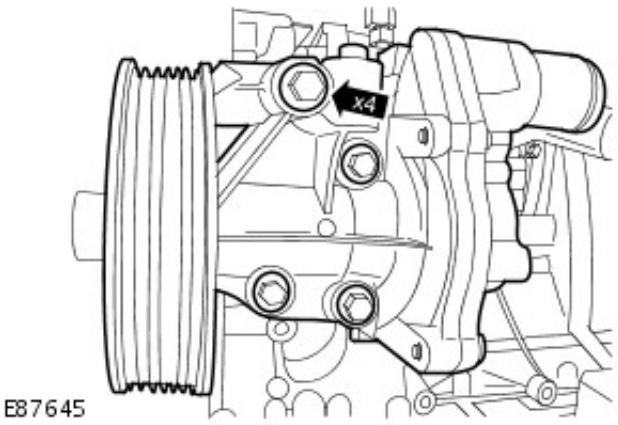
- Release the clip.



6. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Release the coolant pump outlet manifold.

- Remove the 3 bolts.
- Remove and discard the O-ring seal.

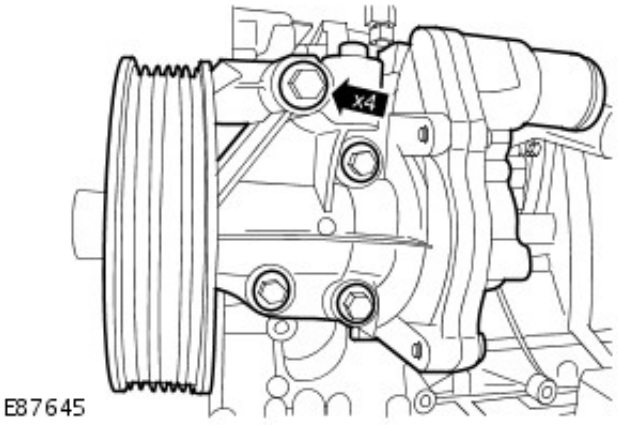


7. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the coolant pump.

- Remove the 4 bolts.
- Remove and discard the gasket.

Installation

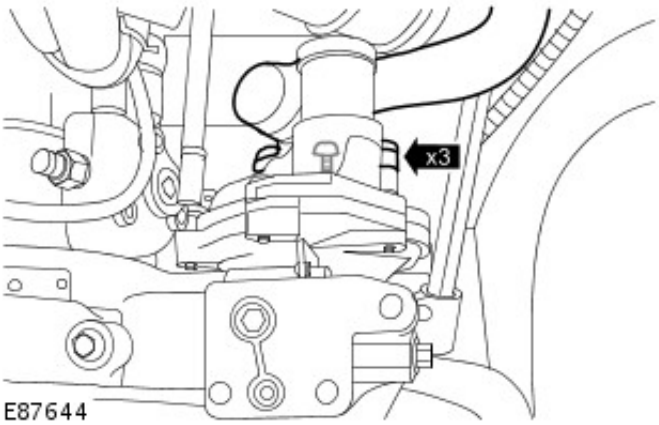


1. NOTE: Remove and discard the blanking caps.

- NOTE: Clean the component mating faces.
- NOTE: Install a new gasket.

Install the coolant pump.

- Tighten to 23 Nm (17 lb.ft).



2. NOTE: Remove and discard the blanking caps.

- NOTE: Clean the component mating faces.
- NOTE: Install a new O-ring seal.

Secure the coolant pump outlet manifold.

- Tighten to 10 Nm (7 lb.ft).

3. NOTE: Remove and discard the blanking caps.

Connect the coolant hose to the coolant pump.

- Tighten the clip to 3 Nm (2 lb.ft).

4. Install the brake vacuum pump.
For additional information, refer to: Brake Vacuum Pump (206-07 Power Brake Actuation, Removal and Installation).

5. Fill and bleed the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

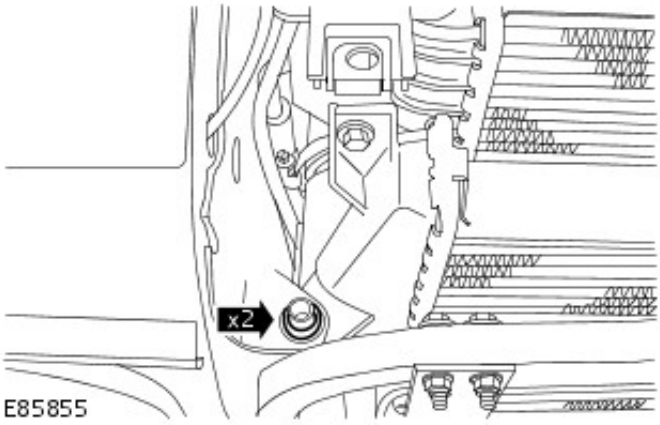
Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Radiator

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the cooling fan shroud.
   For additional information, refer to: Cooling Fan Shroud (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Remove the hood latch panel.
   For additional information, refer to: Hood Latch Panel (501-27 Front End Sheet Metal Repairs, Removal and Installation).
4. NOTE: RH shown, LH similar.

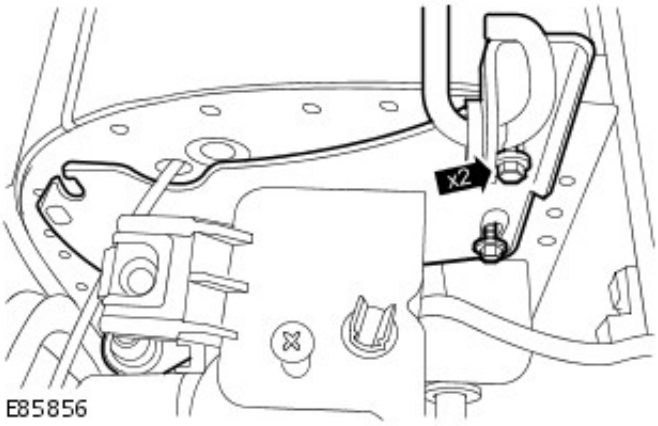
   Remove the 2 O-rings.



5. NOTE: RH shown, LH similar.

   Remove the 2 charge air cooler brackets.

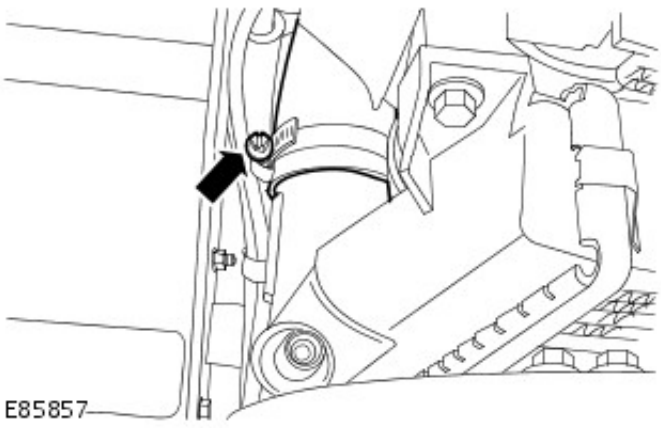
   - Remove the 4 bolts.



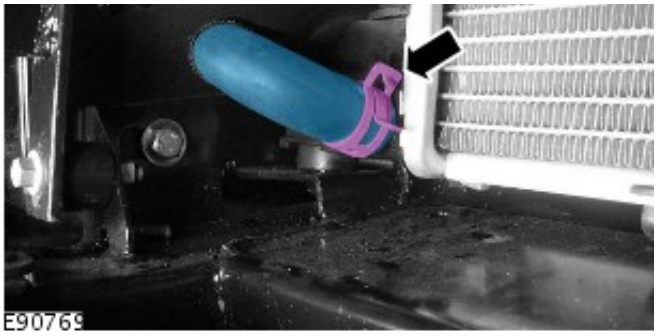
6. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   • NOTE: RH shown, LH similar.

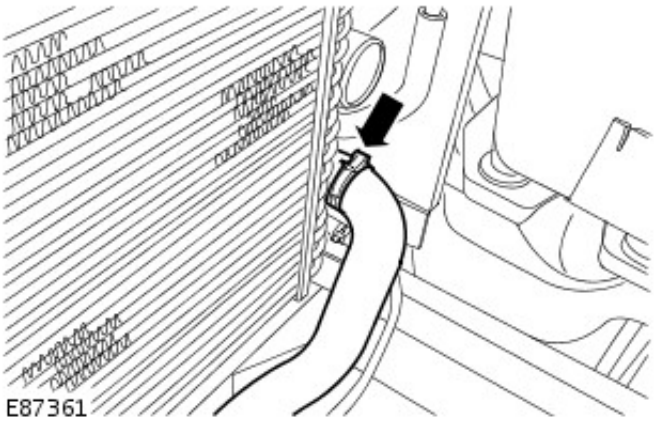
   Disconnect the charge air cooler inlet hose and charge air cooler outlet hose.



7. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

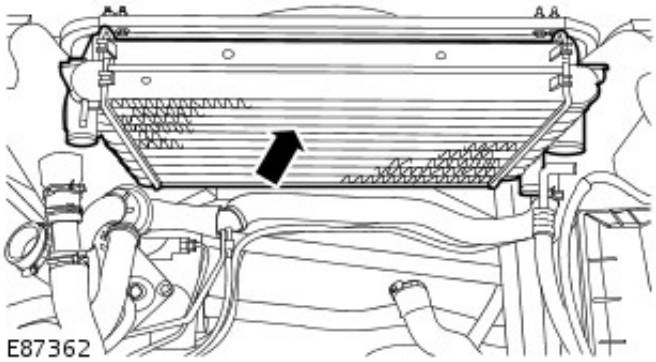

E90769

Disconnect the fuel cooler to radiator hose.


E87361

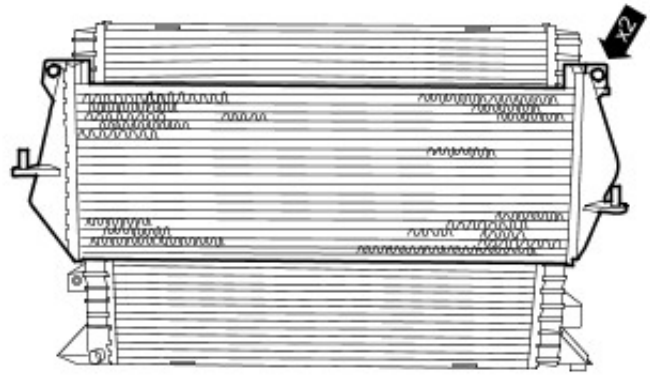
8. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the radiator bottom hose.


E87362

9. CAUTION: Make sure that the radiator and charge air cooler are not damaged when removed.

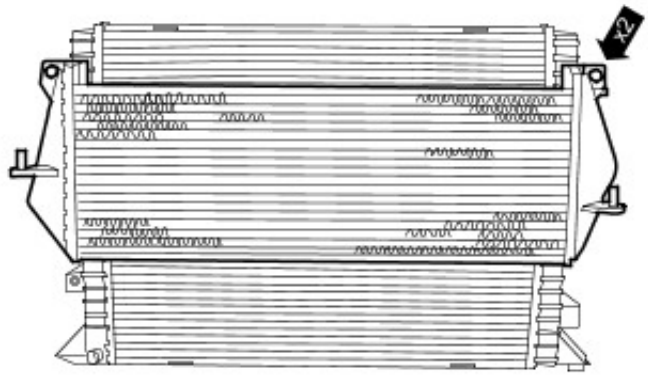
Remove the radiator and charge air cooler assembly.


E87363

10. Remove the radiator.

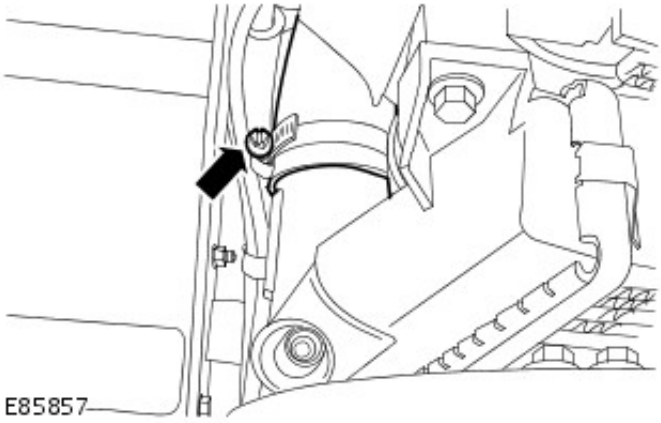
Installation

1. To install, reverse the removal procedure.



E87363

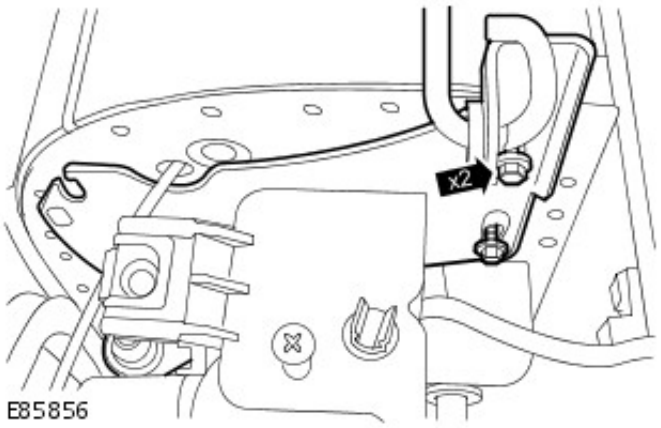
- Tighten to 20 Nm (15 lb.ft).


E85857

2. NOTE: Remove and discard the blanking caps.

• NOTE: RH shown, LH similar.

Tighten to 3 Nm (2 lb.ft).



E85856

3. Tighten to 9 Nm (7 lb.ft).

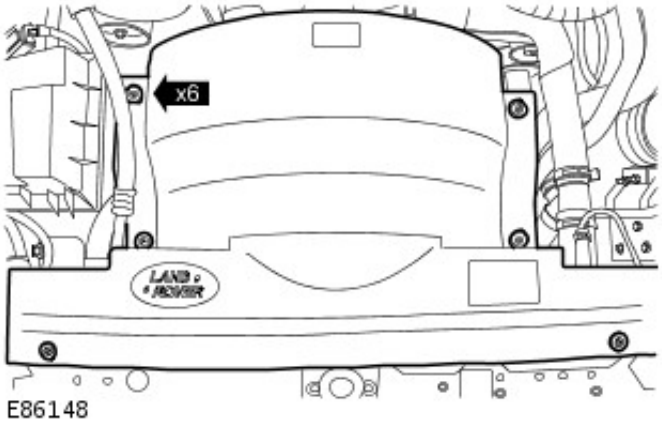
4. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Thermostat

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Drain the cooling system.
   For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
3. Remove the cooling fan upper shroud.
   - Release the 6 clips.

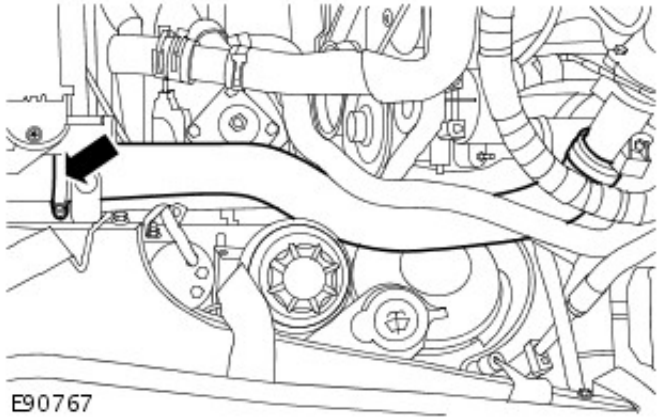


E86148

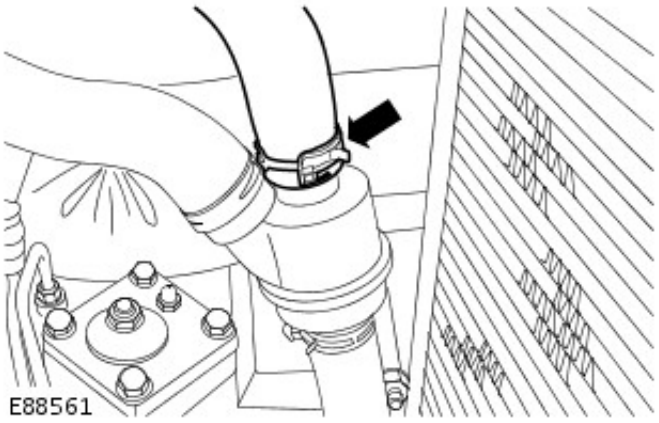
4. Release the power steering fluid reservoir.
   - Remove the 2 nuts.

E87600

5. Disconnect the charge air cooler outlet hose.


E90767

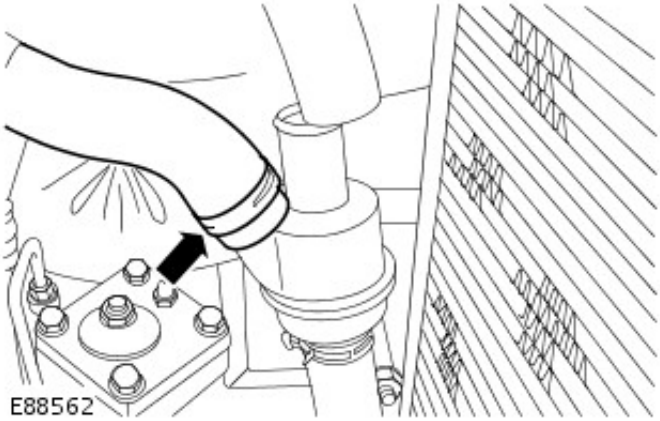
6. NOTE: Cooling fan shroud removed for clarity.



Disconnect the thermostat to radiator top hose.

- Release the clip.

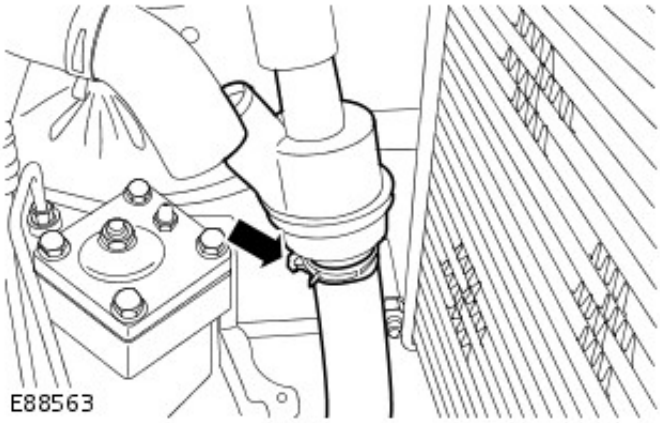
7. NOTE: Cooling fan shroud removed for clarity.



Disconnect the thermostat to coolant pump inlet hose.

- Release the clip.

8. NOTE: Cooling fan shroud removed for clarity.

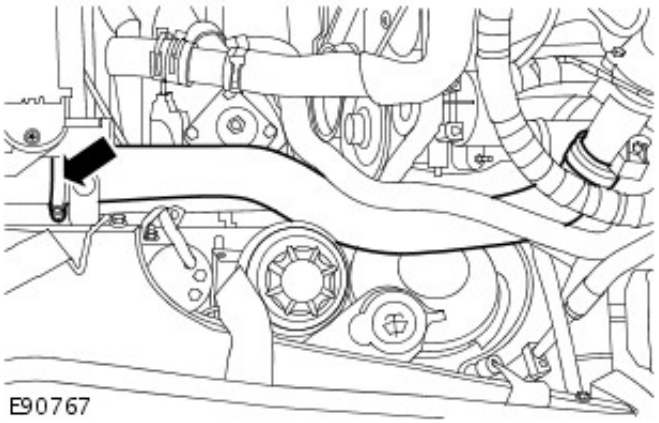


Remove the thermostat.

Installation

1. To install, reverse the removal procedure.

- Tighten to 3 Nm (2 lb.ft).



2. Tighten to 4 Nm (3 lb.ft).

E87600

3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Torque Specifications

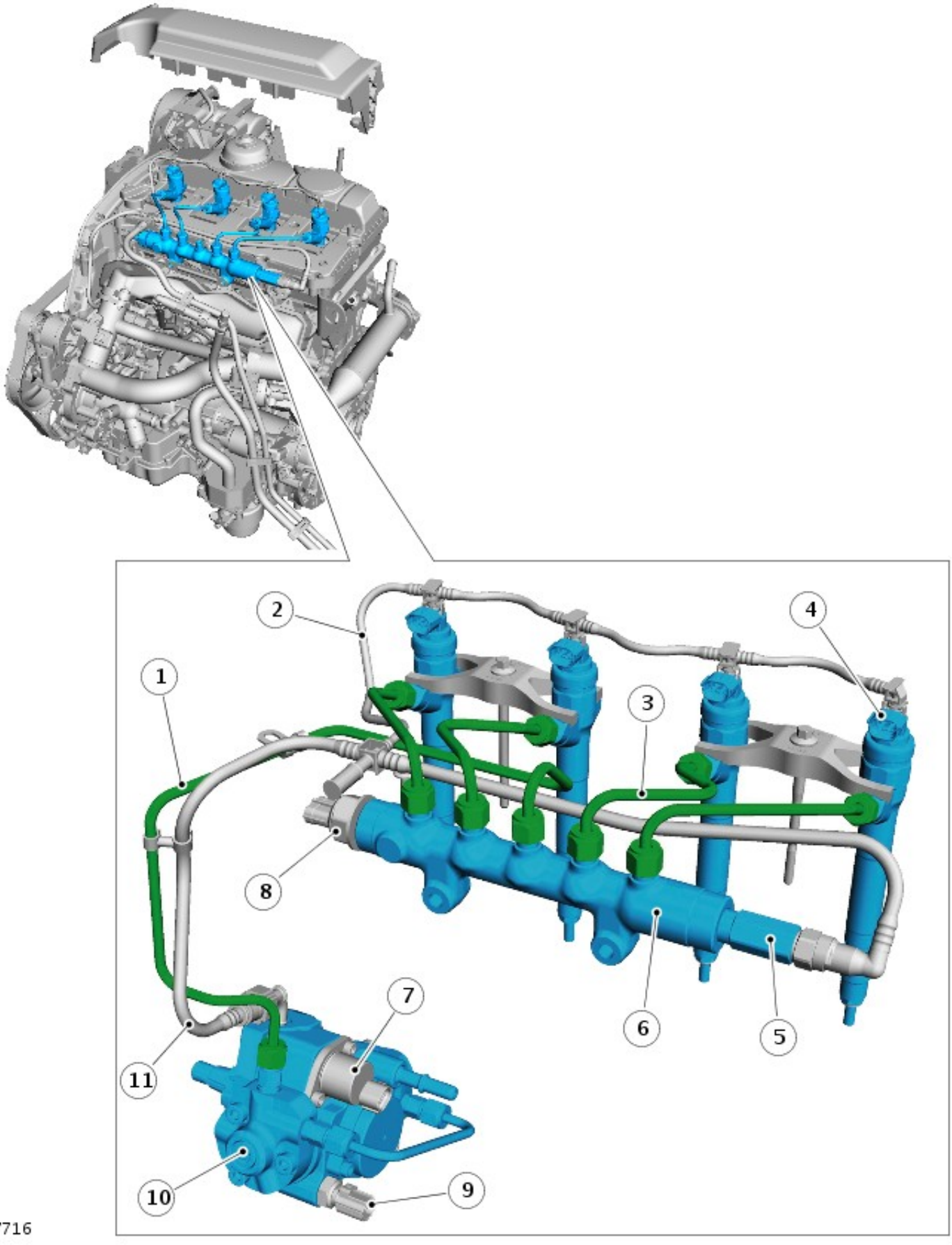
Description	Nm	lb-ft
Fuel injector clamp bolt	A	—
High-pressure fuel supply line unions		
Stage 1	5	4
Stage 2	35	26
Fuel pressure relief valve	A	—
Fuel pump high-pressure fuel supply line bracket bolts	10	7
Fuel pressure relief valve spigot	20	15
Fuel rail to cylinder head		
Stage 1	8	16
Stage 2	23	17
Fuel pump bolts	23	17
Fuel pump drive gear bolts	33	24
Fuel pump drive gear nut	64	47

A = Refer to the procedure for the correct torque sequence

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Charging and Controls

Description and Operation

COMPONENT LOCATION



Item	Part Number	Description

1	-	High-pressure line
2	-	Leak-off pipe
3	-	Fuel injection line
4	-	Fuel injector
5	-	Pressure limiting valve
6	-	Fuel rail
7	-	Volume Control Valve (VCV)
8	-	Fuel pressure sensor
9	-	Fuel temperature sensor
10	-	High-pressure fuel pump
11	-	Fuel return

OVERVIEW

The 2.4 liter diesel engine is equipped with a high-pressure common rail fuel injection system. With this fuel injection process, a high-pressure fuel pump delivers a uniform level of pressure to a shared fuel rail (also known as a common rail), which serves all 4 fuel injectors. Pressure is controlled to the optimum level for smooth operation, up to a pressure of 1600 bar.

The system supports a pre-injection (pilot) phase, which reduces combustion noise and mechanical load.

Fuel injection pressure is generated independently of engine speed and fuel injection events. The fuel injection timing and volume are calculated by the Engine Control Module (ECM), which then energizes the appropriate solenoid actuated injector.

The common rail fuel injection system has the following features:

- High fuel injection pressures of up to 1600 bar for greater atomisation of fuel (increasing performance and lowering emissions)
- Variable injection to optimise combustion in all engine operating conditions
- Low tolerances and high precision throughout the life of the system

The fuel system is divided into 2 sub systems:

- Low-pressure system
- High-pressure system

The LP system features the following components:

- Transfer pump (located in the high-pressure pump)
- Fuel filter
- Fuel cooler

The HP system features the following components:

- High-pressure fuel pump
- Fuel rail
- High-pressure fuel pipes
- Injectors

LOW-PRESSURE SYSTEM

Transfer Pump

The transfer pump is integral to the high-pressure fuel pump and is used to draw fuel from the fuel tank via the fuel filter (for more information refer to the high-pressure fuel pump section).

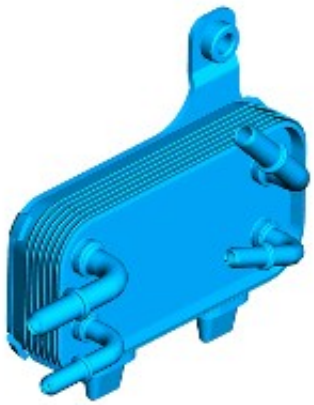
The suction pressure of the transfer pump is -30 to -20 Kpa.

Fuel Filter

E86472

The canister type fuel filter is located forward of the Right Hand (RH) rear wheel and is protected against damage by a steel plate.
For additional information, refer to: Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

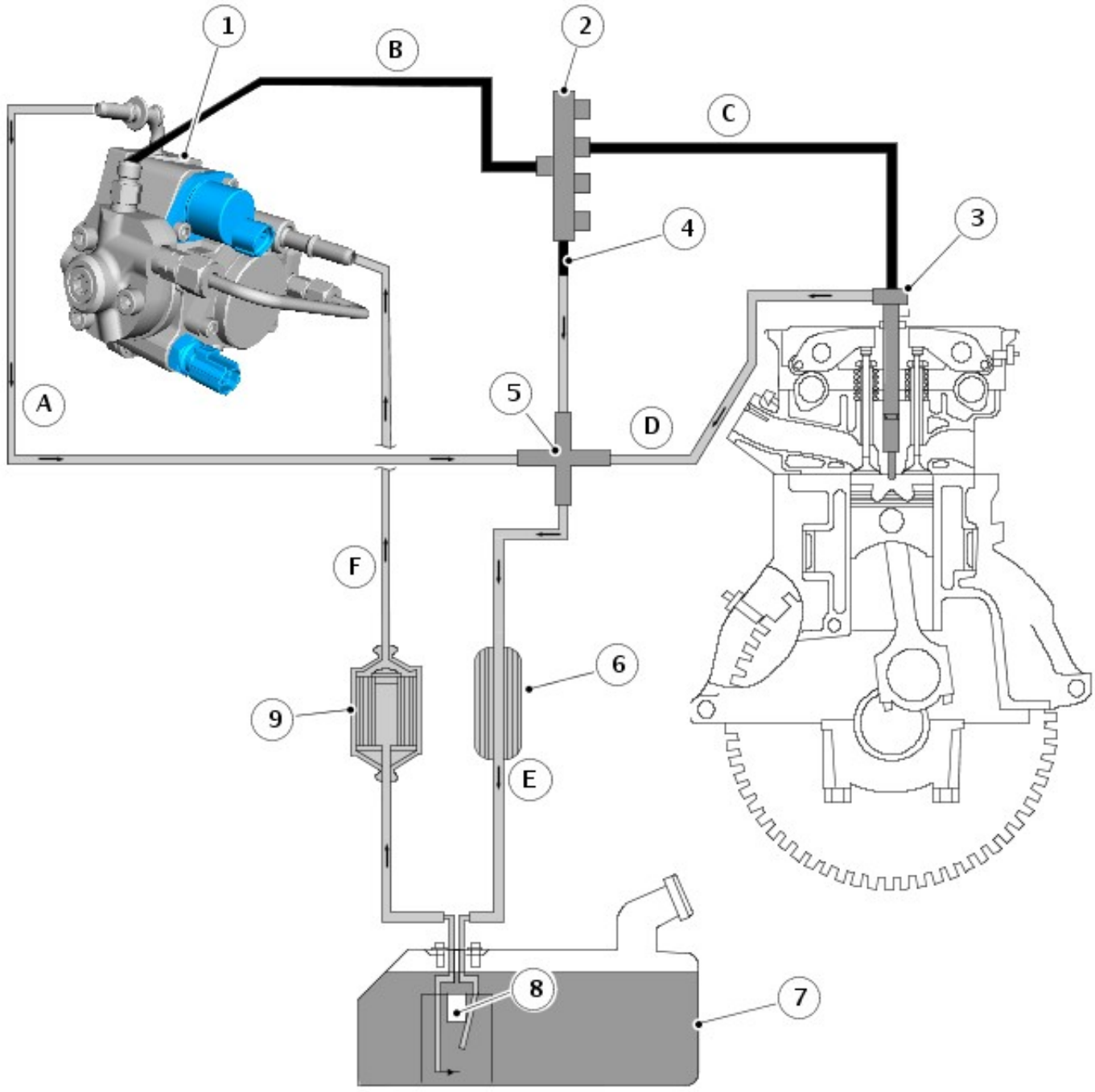
Fuel Cooler



E86473

The water cooled fuel cooler is located behind the Left Hand (LH) front wheel. The cooler has a coolant system connection to aid heat transfer.
For additional information, refer to: Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

HIGH-PRESSURE SYSTEM

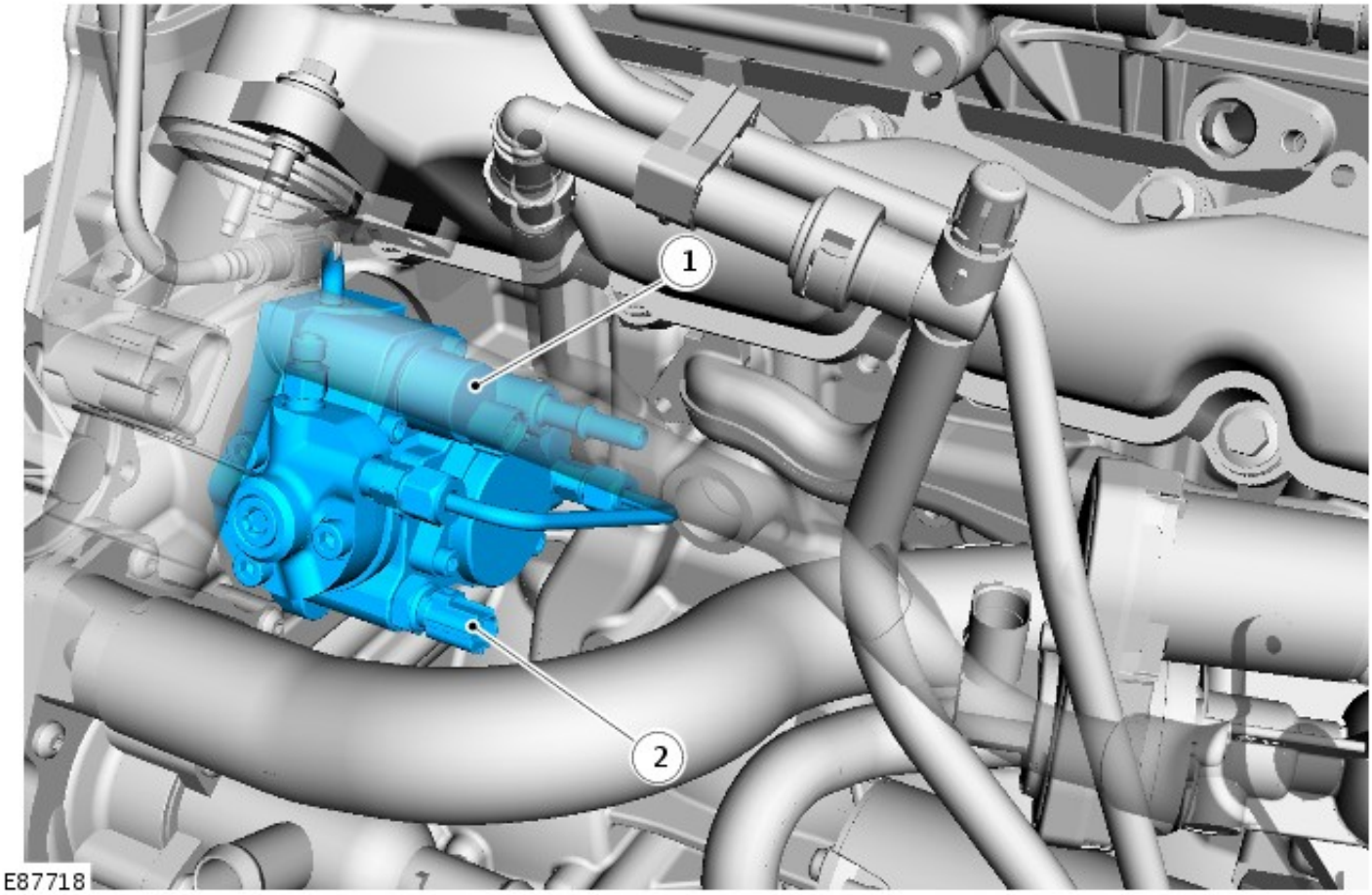


E87717

Item	Part Number	Description
A	-	Fuel return from high-pressure pump
B	-	High-pressure line
C	-	Fuel injection line
D	-	Leak-off pipe
E	-	Fuel return to fuel tank
F	-	Fuel supply
1	-	High-pressure pump
2	-	Fuel rail
3	-	Fuel injector
4	-	Pressure limiting valve
5	-	T-piece
6	-	Fuel cooler
7	-	Fuel tank
8	-	Filling level sensor unit
9	-	Fuel filter

The fuel is drawn from the fuel tank via the fuel filter by means of the transfer pump integrated in the high-pressure pump. The high-pressure pump pressurizes the fuel and forces it into the fuel rail. The fuel pressure required for any given situation is available for the fuel injectors for each injection process. Fuel leaking from the injectors and/or returning fuel from the high-pressure pump are fed back to the fuel tank.

High-Pressure fuel Pump

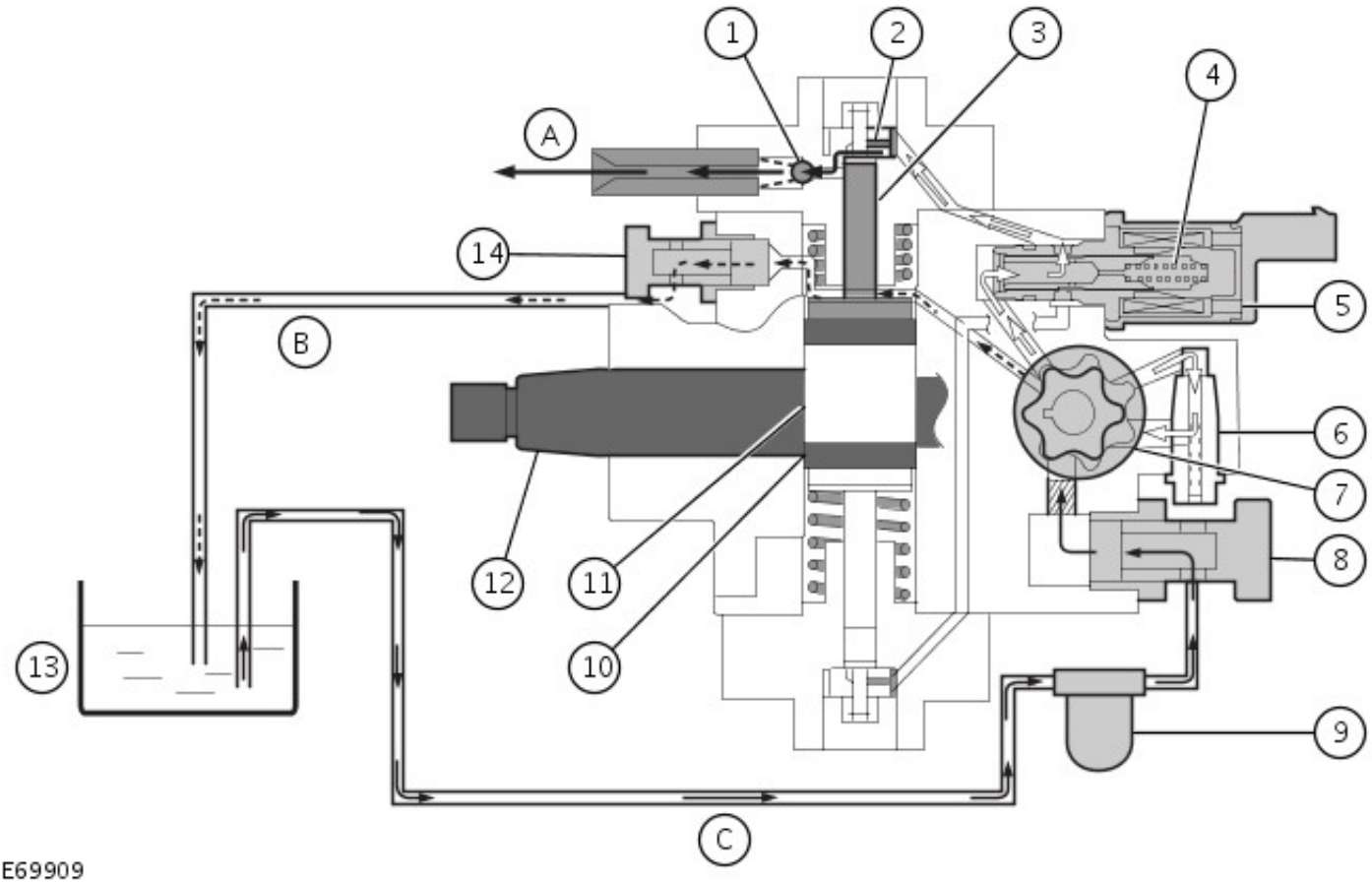


Item	Part Number	Description
1	-	Volume Control Valve (VCV)
2	-	Fuel temperature sensor

The high-pressure fuel pump provides the interface between the low and the high-pressure systems. Its function is to provide sufficient pressurized fuel under all operating conditions and for the entire service life of the vehicle.

The fuel pump is located under the intake manifold and is driven by the timing chain at the front of the engine. The pump includes a transfer pump, a high-pressure pump, a VCV and a fuel temperature sensor.

The high-pressure pump receives fuel at transfer pressure from the transfer pump and increases the fuel pressure. The high-pressure fuel is then transferred from the high-pressure pump to the fuel rail.



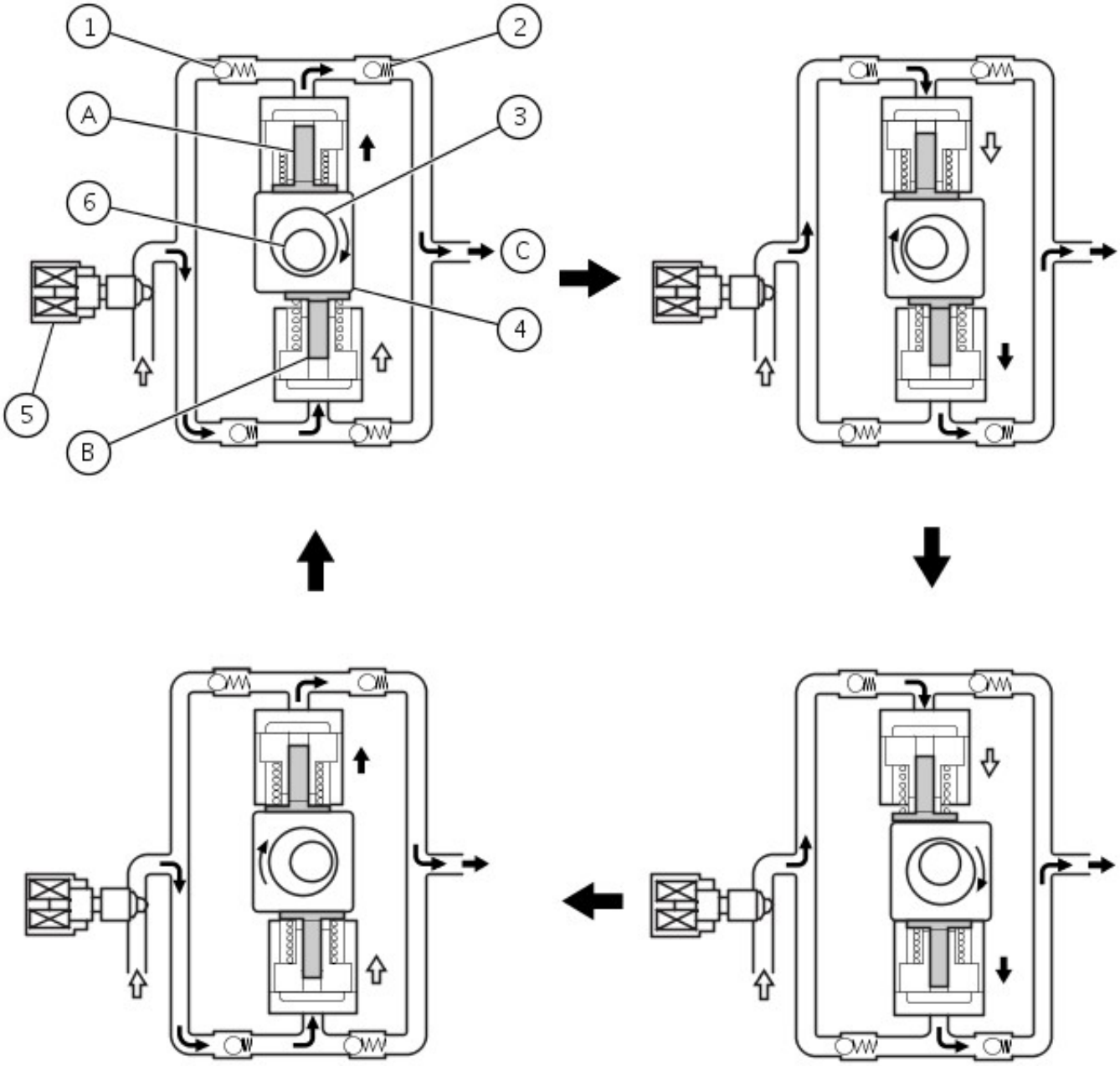
E69909

Item	Part Number	Description
A	-	High-pressure fuel to fuel rail
B	-	Fuel return
C	-	Fuel supply
1	-	High-pressure chamber outlet valve
2	-	High-pressure chamber inlet valve
3	-	Pump plunger
4	-	VCV return spring
5	-	VCV
6	-	Admission pressure control valve (pump internal pressure)
7	-	Transfer pump
8	-	Fuel inlet
9	-	Fuel filter
10	-	Eccentric cam ring
11	-	Eccentric cam
12	-	Drive shaft
13	-	Fuel tank
14	-	Fuel overflow valve

The transfer pump draws fuel out of the fuel tank through the fuel inlet (8). The pump internal pressure is adjusted through the admission-pressure control valve (6), ensuring that sufficient lubrication and cooling are always provided for the high-pressure pump components. The excess fuel is transferred to the inlet side of the transfer pump (7) through the admission-pressure control valve, with a portion of the fuel being transferred to the VCV (5) from the transfer pump. The fuel quantity delivered to the high-pressure chambers is determined by the opening cross-section of the VCV. The small restriction bore in the fuel overflow valve (14) provides for automatic bleeding of the high-pressure pump. The entire low-pressure system is designed to allow a defined quantity of fuel to flow back into the fuel tank through the overflow pressure regulator tube, which assists cooling of the high-pressure pump.

A total of 2 high-pressure chambers (1 and 2), each with a pump plunger (3), are used for high-pressure generation. The drive for the pump plungers is through an eccentric cam (11), which is in turn driven by the drive shaft (12). The high-pressure pump permanently generates the high system pressure for the fuel rail.

Principle of High-Pressure Generation



E69910

Item	Part Number	Description
A	-	Pump plunger 1
B	-	Pump plunger 2
C	-	To fuel rail
1	-	Inlet valve
2	-	Outlet valve
3	-	Eccentric cam
4	-	Eccentric cam ring
5	-	Fuel metering valve
6	-	Drive shaft

The rotary movement of the drive shaft (6) is converted to reciprocating movement by the eccentric cam (3). The eccentric cam ring (4) transfers the reciprocating movement to the pump plungers (1 and 2).

The pump plungers are offset by 180 degrees. This means that during a reciprocating movement, pump plunger 1 performs exactly the opposite movement to pump plunger 2.

When the eccentric cam produces an upward stroke, pump plunger 1 moves in the direction of Top Dead Center (TDC), thus compressing the fuel and delivering it to the fuel rail via the outlet valve (2). The inlet valve (1) is pressed into its seat by the delivery pressure. Pump plunger 2 is moved by the tension spring force in the direction of Bottom Dead Center (BDC). Due to the high pressure in the fuel rail, the outlet valve is pressed into its seat. The pump internal pressure opens th inlet valve and fuel flows into the high-pressure chamber.

When the eccentric cam produces a downward stroke, the process is reversed.

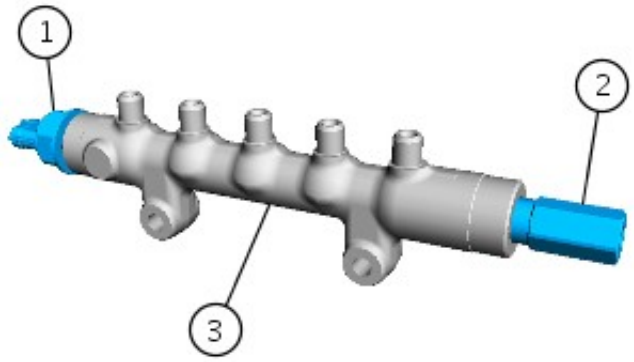
The VCV is located on the high-pressure fuel pump. The valve regulates the fuel supply (and hence the quantity of fuel) from the transfer pump to the high-pressure fuel pump elements, depending on the fuel pressure in the rail. This makes it possible to match the delivery of the high-pressure fuel pump to the requirements of the engine from the low-pressure side. The quantity of fuel flowing back to the main fuel supply line is kept to a minimum. In addition, this adjustment reduces the power consumption of the high-pressure fuel pump, improving the efficiency of the engine.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

After replacing the high-pressure pump and/or the ECM, the VCV must be calibrated with the aid of approved Land Rover diagnostic equipment.

The fuel temperature sensor is also located on the high-pressure fuel pump. The ECM monitors the fuel temperature constantly so it can respond correctly to changes in fuel density in relation to fuel temperature.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

If the fuel temperature sensor is disconnected the engine will operate at reduced power and a DTC will be triggered.

Fuel Rail



E69911

Item	Part Number	Description
1	-	Fuel pressure sensor
2	-	Pressure limiting valve
3	-	Fuel rail

The fuel rail performs the following functions:

- Stores fuel under high pressure
- Minimizes pressure fluctuations

Pressure fluctuations are induced in the high-pressure fuel system by operating movements in the high-pressure chambers of the fuel pump and the opening and closing of the solenoid valves on the fuel injectors. Consequently, the fuel rail is designed in such a way that it has sufficient volume to minimize pressure fluctuations, but low enough volume to be able to build up the fuel pressure required for a quick start in the shortest time possible.

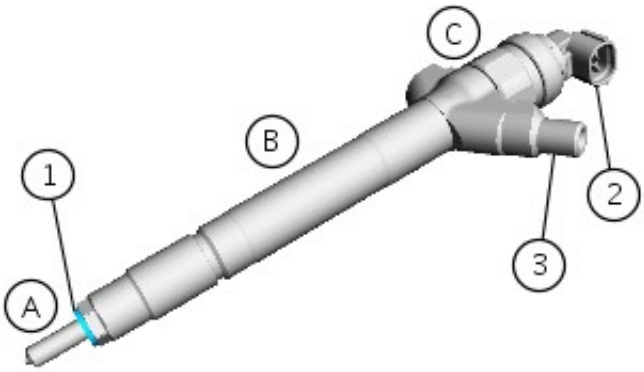
The fuel supplied by the high-pressure pump passes through a high-pressure line to the high-pressure accumulator. The fuel is then sent to the individual fuel injectors via the 4 injector tubes, which are all the same length. When fuel is taken from the fuel rail for an injection process, the pressure in the fuel rail is kept almost constant.

The pressure limiting valve opens at a fuel pressure of approximatly 2000 bar. It serves as a safety device in the case of malfunctions in the high-pressure system, preventing damage due to excessive pressure. The valve operates as a disposable unit and must be replaced after a single trigger, as the valve can no longer be guaranteed leak-free. Triggering of the pressure limiting valve is detected by the ECM, whereupon a corresponding Diagnostic Trouble Code (DTC) is set and the Malfunction Indicator Lamp (MIL) is actuated.

The fuel rail pressure sensor is located in the end of the fuel rail. The sensor measures the pressure of the fuel in the fuel rail. This input is then used by the ECM to control the amount of fuel delivered to the fuel rail.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

If the pressure sensor is disconnected the engine will operate at reduced power and a DTC will be triggered. The sensor is not serviceable, and will come as part of a new rail with the limitting valve.

Fuel Injectors



E69912

Item	Part Number	Description
A	-	Fuel injector nozzle
B	-	Hydraulic servo system
C	-	Solenoid valve
1	-	Combustion chamber seal
2	-	Electrical connection - solenoid valve
3	-	High-pressure fuel line connection

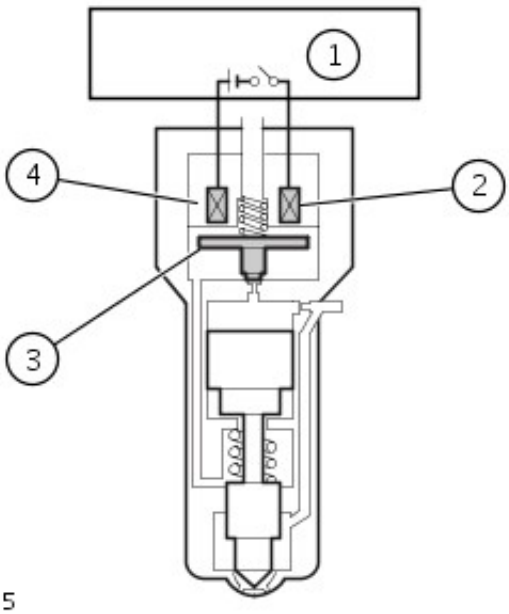
The 4 fuel injectors are located in the cylinder head, between the 4 valves in each cylinder. Each injector is sealed into the cylinder head with a copper washer. Each injector has an electrical connector for power supply and connections to the ECM. The fuel injectors are operated directly by the ECM for fuel metering (start of injection and quantity of fuel injected). The top of each injector is fitted with a fuel return pipe, which allows fuel used in the operation of the injector to return to the tank.

• NOTE: The copper washers that seal the injectors in the cylinder head must not be re-used.

Each electronic injector has a solenoid valve, which when energised, allows a ball valve to lift off its seat. This allows pressurised fuel to lift a needle valve in the injector nozzle and spray a finely atomised jet of fuel into the cylinder. Fuel that spills past the ball valve is directed into a return line, which is connected to the fuel return from the high-pressure fuel pump.

Each injector solenoid is controlled separately by the ECM, which provides an earth path to open the injector nozzle at the correct time and for a calculated period to provide a metered injection of fuel into the cylinder. The ECM uses signals from other sensors and a programmed fuelling strategy to ensure that the precise amount of fuel is injected at the correct timing for maximum fuel efficiency and minimum emissions.

Fuel Injector Solenoid Valve



E70325

Item	Part Number	Description
1	-	ECM
2	-	Coil
3	-	Solenoid armature
4	-	Solenoid valve

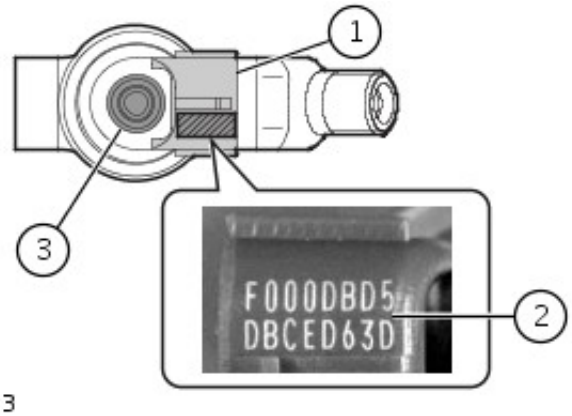
The ECM applies current to the injector solenoid valves in 3 stages:

- 1. 18 amps

- 2. 8 amps
- 3. 4 amps

At the beginning of an injection process, the solenoid valve is actuated with a higher pick-up current so that it opens quickly. After a short period of time, the pick-up current is reduced to a low holding current.

To ensure optimum fuel metering, the ECM must be informed of a change of injector through the input of a 16-digit identification number. Inside the hydraulic servo system there are various restrictions with extremely small diameters, which have specific manufacturing tolerances. These manufacturing tolerances are given as part of the identification number, which is located on the housing of the fuel injector.



E69913

Item	Part Number	Description
1	-	Solenoid valve
2	-	16-digit identification number
3	-	Connection for leak-off pipe

• NOTE: If the identification numbers are not entered correctly with the approved Land Rover diagnostic equipment, the following faults may occur:

- Increased black smoke formation
- Irregular idling
- Increased combustion noise

Furthermore, once new ECM software has been loaded with the approved Land Rover diagnostic equipment, the fuel injectors must also be configured.

The ECM detects injector faults based on the power consumption of the solenoid valves. In the event of a fuel injector failure, any of the following symptoms may be observed:

- Engine misfire
- Idle faults
- Reduced engine performance
- Reduced fuel economy
- Difficult cold start
- Difficult hot start
- Increased smoke emissions

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Charging and Controls

Diagnosis and Testing

Overview

This section covers the fuel system from the fuel filter to the fuel injectors, and includes the fuel rail and pump.

For information on the operation of the systems:
REFER to: Fuel Charging and Controls (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation) /
Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

WARNING: Make sure that all suitable safety precautions are observed when carrying out any work on the fuel system. failure to observe this warning may result in personal injury.

CAUTION: Make sure that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines. failure to follow this instruction may result in damage to the vehicle.

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

Visual Inspection Chart

Mechanical	Electrical
• Low/contaminated fuel • Fuel supply/return line(s) • Fuel tank and filler pipe • Fuel leak(s) • Fuel filler cap • Fuel filter • Push connect fittings • Fuel pressure limiting valve • Fuel rail • Fuel injection pump • Exhaust gas recirculation (EGR) system	• Fuses • Glow plug indicator • Inertia fuel shutoff (IFS) switch • Sensor(s) • Engine control module (ECM) • Fuel suction control valve • Fuel rail pressure sensor • Fuel temperature sensor • Fuel injector(s) • EGR system

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible causes	Action
Engine cranks, but does not start	• Inertia fuel shutoff (IFS) switch • Low/contaminated fuel • Air leakage • Low-pressure fuel system fault • Blocked fuel filter • Fuel suction control valve blocked/contaminated • Fuel injection pump fault • Crankshaft position (CKP) sensor	Check that the IFS has not tripped. Check the main ECM relay and circuits, refer to the electrical guides. Check the fuel level and condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel injection pump fault. Check the fuel injection pump: REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the CKP sensor circuits. Refer to the electrical guides. Install a new CKP sensor if necessary. REFER to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Difficult to start	• Glow plug system fault (very cold conditions) • Low/contaminated fuel	Check the glow plug circuits. Refer to the electrical guides. Check the fuel

	fuel • Air leakage • Low-pressure fuel system fault • Blocked fuel filter • Fuel suction control valve blocked/contaminated • Exhaust gas recirculation (EGR) valve(s) fault	level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel suction control valve fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Rough idle	• Intake air system fault • Low/contaminated fuel • Low-pressure fuel system fault • Blocked fuel filter • Fuel suction control valve blocked/contaminated • Exhaust gas recirculation (EGR) valve(s) fault	Check the intake air system for leaks. Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel suction control valve fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Lack of power when accelerating	• Intake air system fault • Restricted exhaust system • Low fuel pressure • Exhaust gas recirculation (EGR) valve(s) fault • Turbocharger actuator fault	Check the intake air system for leakage or restriction. Check for a blockage/restriction in the exhaust system, install new components as necessary: REFER to: Catalytic Converter (309-00 Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check for DTCs indicating a fuel pressure fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing). For turbocharger actuator checks: REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Engine stops/stalls	• Air leakage • Low/contaminated fuel • Low-pressure fuel system fault • High-pressure fuel leak • Fuel suction control valve blocked/contaminated • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks. Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the fuel system for leaks/damage. Check for DTCs indicating a fuel suction control valve fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Engine judders	• Low/contaminated fuel • Air ingress • Low-pressure fuel system fault • Fuel suction control valve blocked/contaminated • High-pressure fuel leak • Fuel injection pump fault	Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the high-pressure fuel system for leaks. Check for DTCs indicating a fuel suction control valve fault. Check the fuel injection pump: REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Excessive fuel consumption	• Low-pressure fuel system fault • Fuel suction control valve blocked/contaminated • Fuel temperature sensor leak • High-pressure fuel leak • Injector(s) fault	Check the low-pressure fuel system for leaks/damage. Check for DTCs indicating a fuel suction control valve fault. Check the fuel temperature sensor, fuel injection pump, etc. for leaks. Check for injector DTCs. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

	• Exhaust gas recirculation (EGR) valve(s) fault		

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible causes	Action
P008807	Fuel rail/system pressure - too high	• Fuel rail pressure sensor to engine control module (ECM) wiring (supply/signal): short circuit to each other • Fuel rail pressure sensor to ECM signal circuit: short circuit to power • Fuel rail pressure sensor fault • Fuel injection pump circuit: short circuit to power • Fuel injection pump fault • Fuel rail pressure limiting valve	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor cannot be serviced separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and carry out a road test to confirm repair.
P008809	Fuel rail/system pressure - too high	• Fuel rail pressure sensor to engine control module (ECM) wiring (supply/signal): short circuit to each other • Fuel rail pressure sensor to ECM sensor circuit: short circuit to power • Fuel rail pressure sensor fault • Fuel injection pump circuit: short circuit to	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor cannot be serviced separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

		power • Fuel injection pump fault • Fuel rail pressure limiting valve	Clear the DTCs and carry out a road test to confirm repair.
P00897A	Fuel pressure regulator performance	• Fuel rail pressure limiting valve has activated	The fuel rail pressure limiting valve operates as a disposable item in the event of excess system pressure. Once activated the valve cannot be guaranteed leak free and should be replaced. Install a new fuel rail pressure limiting valve. REFER to: Fuel Pressure Relief Valve (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
P009111	Fuel pressure regulator control circuit - circuit short to ground	• Fuel suction control valve circuit: short circuit to ground • Fuel suction control valve fault	Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009112	Fuel pressure regulator control circuit - circuit short to battery	• Fuel suction control valve circuit: short circuit to power • Fuel suction control valve fault	
P009211	Fuel pressure regulator control circuit - circuit short to ground	• Fuel suction control valve circuit: short circuit to ground • Fuel suction control valve fault	Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009212	Fuel pressure regulator control circuit - circuit short to battery	• Fuel suction control valve circuit: short circuit to power • Fuel suction control valve fault	
P01802F	Fuel temperature sensor A circuit - signal erratic	• Fuel temperature sensor circuit: short circuit to ground • Fuel temperature sensor circuit: short circuit to power • Fuel temperature sensor circuit: open circuit • Fuel temperature sensor fault	Check the fuel temperature sensor and circuits. Refer to the electrical guides. The fuel temperature sensor is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P018011	Fuel temperature sensor A circuit - circuit short to ground	• Fuel temperature sensor circuit: short circuit to ground • Fuel temperature sensor fault	
P018015	Fuel temperature	• Fuel	

	sensor A circuit - circuit short to battery or open	temperature sensor circuit: short circuit to power • Fuel temperature sensor circuit: open circuit • Fuel temperature sensor fault	
P019011	Fuel rail pressure sensor A circuit - circuit short to ground	• Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P019015	Fuel rail pressure sensor A circuit - circuit short to battery or open	• Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	
P019164	Fuel rail pressure sensor A circuit range/performance - signal plausibility failure	• Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020011	Injector circuit - circuit short to ground	• Injector circuit: short circuit to ground • Injector fault	Check the injector and injector circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020012	Injector circuit - circuit short to battery	• Injector circuit: short circuit to power • Injector fault	
P020100	Cylinder 1 (injector 1) circuit / open	• Cylinder 1 injector circuit: open circuit • Cylinder 1 injector fault	Check the cylinder 1 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020200	Cylinder 2 (injector 4) circuit / open	• Cylinder 2 injector circuit: open circuit • Cylinder 2 injector fault	Check the cylinder 2 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020300	Cylinder 3 (injector 2) circuit / open	• Cylinder 3 injector circuit: open circuit	Check the cylinder 3 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls -

		• Cylinder 3 injector fault	2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020400	Cylinder 4 (injector 3) circuit / open	• Cylinder 4 injector circuit: open circuit • Cylinder 4 injector fault	Check the cylinder 4 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P026100	Cylinder 1 injector 1 circuit low	• Cylinder 1 injector circuit: short circuit to ground • Cylinder 1 injector fault	Check the cylinder 1 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P026400	Cylinder 2 injector 4 circuit low	• Cylinder 2 injector circuit: short circuit to ground • Cylinder 2 injector fault	Check the cylinder 2 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P026700	Cylinder 3 injector 2 circuit low	• Cylinder 3 injector circuit: short circuit to ground • Cylinder 3 injector fault	Check the cylinder 3 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P027000	Cylinder 4 injector 3 circuit low	• Cylinder 4 injector circuit: short circuit to ground • Cylinder 4 injector fault	Check the cylinder 4 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P029C00	Cylinder 1 balance - (injector 1) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A000	Cylinder 2 balance - (injector 4) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A400	Cylinder 3 balance - (injector 2) restricted	• Injector leak • Cylinder compression low - Blow-by past the	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the

		injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A800	Cylinder 4 balance - (injector 3) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P062B16	Internal control module fuel injector control performance - circuit voltage below threshold	• Engine control module (ECM) fault	Refer to the warranty and policy and procedures manual if the ECM is suspect.
P062B17	Internal control module fuel injector control performance - circuit voltage above threshold	• Engine control module (ECM) fault	
P115A00	Low fuel level - forced limited power	• Low fuel • Fuel level sensor circuit: short circuit to ground • Fuel level sensor circuit: open circuit • Fuel level sensor fault	Check that there is sufficient fuel in the tank. Check the fuel level sensor and circuits. Refer to the electrical guides. Install a new fuel level sensor if necessary. REFER to: Fuel Level Sender (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P115B00	Low fuel level - forced engine shutdown	• Low fuel • Fuel level sensor circuit: short circuit to ground • Fuel level sensor circuit: open circuit • Fuel level sensor fault	Check that there is sufficient fuel in the tank. Check the fuel level sensor and circuits. Refer to the electrical guides. Install a new fuel level sensor if necessary. REFER to: Fuel Level Sender (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P116900	Fuel rail pressure sensor in range but high	• Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

P121C00	Cylinder balance - injector leaking	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
P129300	Injector high side open - bank 1 - cylinders 1 or 4 (injectors 1 or 3)	• Fuel injector circuit (high side): open circuit • Fuel injector circuit (high side): short circuit to ground • Fuel injector circuit (high side): short circuit to power • Fuel injector fault	Check the fuel injectors and circuits. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P129400	Injector high side open - bank 2 - cylinders 2 or 3 (injectors 4 or 2)	• Fuel injector circuit (high side): open circuit • Fuel injector circuit (high side): short circuit to ground • Fuel injector circuit (high side): short circuit to power • Fuel injector fault	Check the fuel injectors and circuits. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P167B00	Fuel injector learning not done	• Pilot correction learning procedure has not been completed • Engine control module (ECM) fault	Run pilot correction learning function in line with service procedures. Clear the DTCs and test for normal operation. Refer to the warranty and policy and procedures manual if the ECM is suspect.
P167B41	Fuel injector learning not done - general checksum failure	• Pilot correction learning procedure corrupted • Engine control module (ECM) fault	
P214716	Fuel injector group A supply voltage circuit low - injector boost voltage too low	• Engine control module (ECM) fault	Clear the DTC. Start the engine and retest. Refer to the warranty policy and procedures manual if the ECM is suspect.
P214817	Fuel injector group A supply voltage circuit high - injector boost voltage too high	• Engine control module (ECM) fault	Clear the DTC. Start the engine and retest. Refer to the warranty policy and procedures manual if the ECM is suspect.

P263507	Fuel pump A low flow / performance	Fuel supply pump insufficient flow	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P268B00	High-pressure fuel pump calibration not learned/programmed	Pump learning procedure not run	Run pump learning procedure
P268C00	Cylinder 1 (injector 1) data incompatible	• Cylinder 1 (injector 1) classification code invalid	Re-enter the injector codes using the approved diagnostic system. Clear the DTCs, test for normal operation.
P268D00	Cylinder 3 (injector 2) data incompatible	• Cylinder 3 (injector 2) classification code invalid	
P268E00	Cylinder 4 (injector 3) data incompatible	• Cylinder 4 (injector 3) classification code invalid	
P268F00	Cylinder 2 (injector 4) data incompatible	• Cylinder 2 (injector 4) classification code invalid	

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Injection Component Cleaning

General Procedures

General Equipment

Pneumatic vacuum gun

1. WARNINGS:

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 1700 bar (24,656 lb-sq-in). Failure to follow this instruction may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Place the vehicle in a well ventilated, quarantined area and arrange ' No Smoking/Petrol Fumes' signs about the vehicle.

Wait at least 30 seconds after the engine stops before commencing any repair to the high-pressure fuel injection system. Failure to follow this instruction may result in personal injury.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

• CAUTIONS:

Before using the cleaning fluid, protect all electrical components and connectors with lint-free non-flocking material.

Make sure that all parts removed from the vehicle are placed on the lint-free non-flocking material.

Make sure that any protective clothing worn is clean and made from lint-free non-flocking material.

Make sure that clean non-plated tools are used. Clean tools using a new brush that will not lose its bristles and fresh cleaning fluid, prior to starting work on the vehicle.

Use a steel topped workbench and cover it with clean, lint-free non-flocking material.

Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

Using a new brush that will not lose its bristles, brush cleaning fluid onto the components being removed and onto the surrounding area.

2. Using a pneumatic vacuum gun, remove all traces of cleaning fluid and foreign material.

3. Dispose of any used cleaning fluid and the brush after completing the repair.

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Injector

Removal and Installation

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

• CAUTIONS:

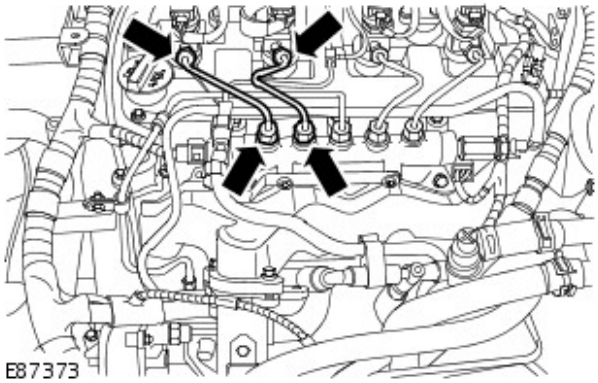
Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

Always carry out the cleaning process before carrying out any repairs to the fuel injection system components. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

Do not disconnect the fuel injector electrical connectors with the engine running. Failure to follow this instruction may result in serious damage to the engine.

Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the engine cover.
   For additional information, refer to: Engine Cover (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
   For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
4. CAUTIONS:

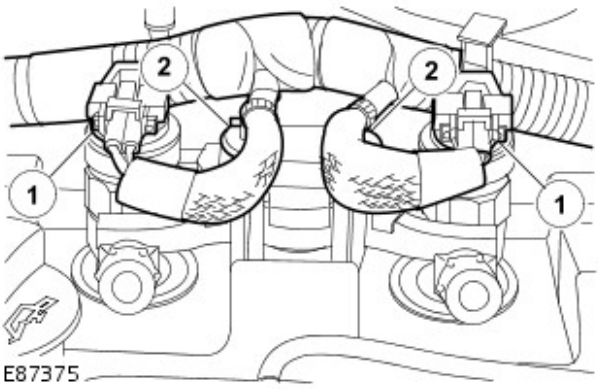


4. CAUTIONS:

⚠ Do not allow the unions to hit the olive ends of the high-pressure fuel supply line as this may damage the ends of the line and allow foreign matter to enter the fuel injection system.

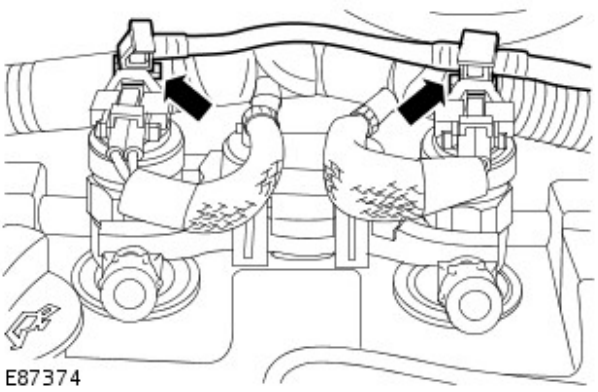
⚠ Make sure that all openings are sealed. Use new blanking caps.

Remove and discard the 2 high-pressure fuel supply lines.



5. Release the fuel injector wiring harness.

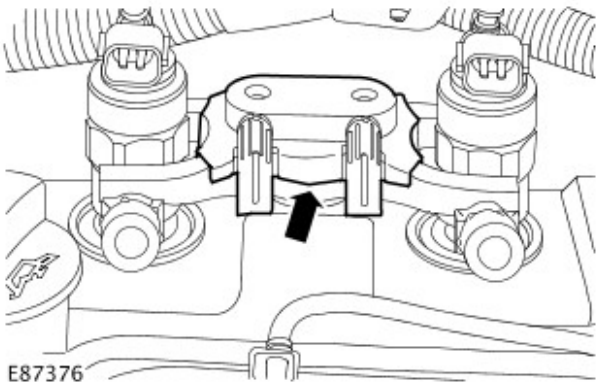
1. Disconnect the 2 fuel injector electrical connectors.
2. Release the 2 clips.



6. ⚠ CAUTION: Make sure that all openings are sealed. Use new blanking caps.

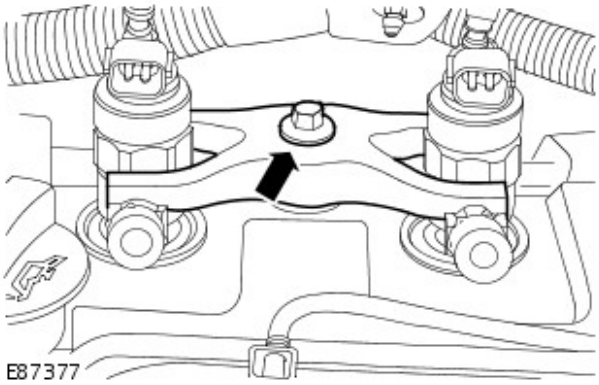
Release the fuel return line.

- Remove the 2 clips.
- Remove and discard the 2 O-ring seals.



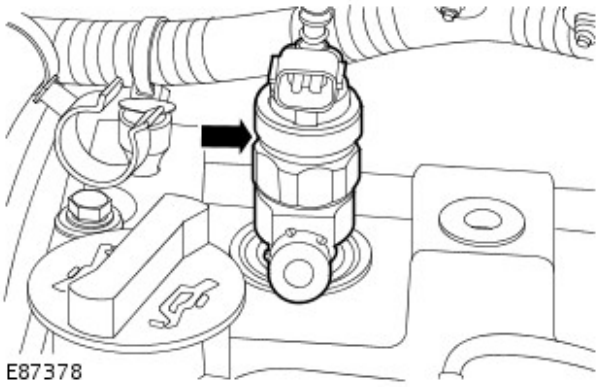
7. Remove the fuel injector clamp cover.

8. NOTE: Note the position of the fuel injector clamp.



Remove the fuel injector clamp.

- Remove and discard the bolt.

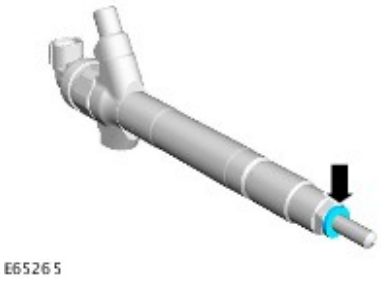


9. CAUTIONS:

Make sure that all openings are sealed. Use new blanking caps.

Make sure that both fuel injectors are removed. Failure to follow this instruction may result in damage to the vehicle.

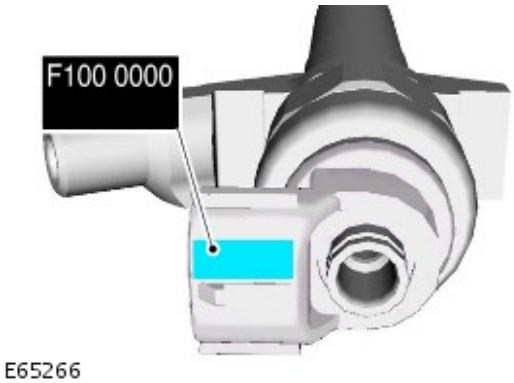
Remove the fuel injector.



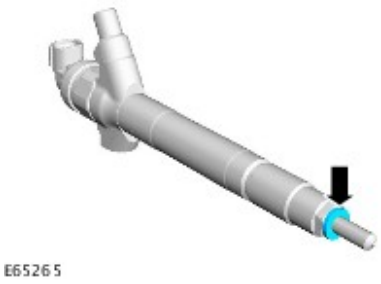
10. Remove and discard the sealing washers from both fuel injectors.

Installation

1. If a new fuel injector is to be installed, record the fuel injector identification code.



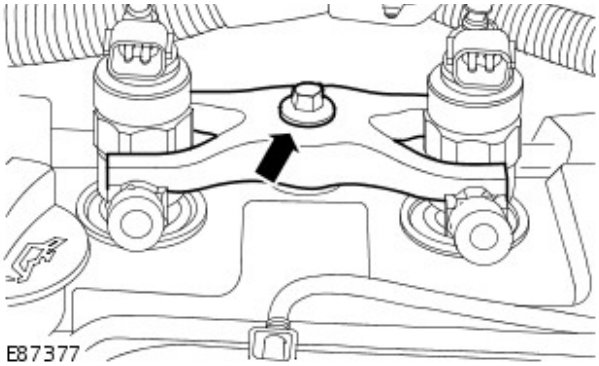
2. Install new sealing washers to both fuel injectors.



3. NOTE: Remove and discard the blanking caps.

Install the fuel injectors.

4. CAUTION: Make sure the fuel injector clamp is


E87377

installed correctly. Failure to follow this instruction may result in damage to the vehicle.

Install the fuel injector clamp.

- Stage 1: Tighten the new bolt to 6 Nm (4 lb.ft).
- Stage 2: Tighten a further 180 degrees.

5. Install the fuel injector clamp cover.

6. NOTE: Remove and discard the blanking caps.

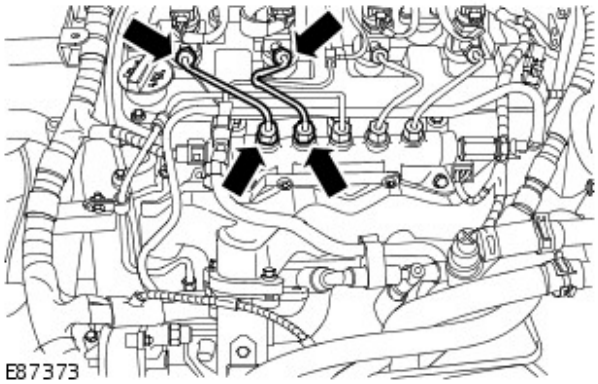
• NOTE: Clean the component mating faces.

Secure the fuel return line.

- Install new O-ring seals.
- Install the clips.

7. Secure the fuel injector wiring harness.

1. Connect the fuel injector electrical connectors.
2. Secure the clips.


E87373

8. NOTE: Remove and discard the blanking caps.

Secure the high-pressure fuel supply lines.

- Stage 1: Tighten the unions to 5 Nm (4 lb.ft).
- Stage 2: Tighten the unions to 35 Nm (26 lb.ft).

9. Install the engine cover.
For additional information, refer to: Engine Cover (501-05 Interior Trim and Ornamentation, Removal and Installation).

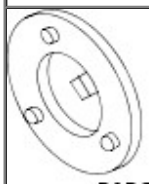
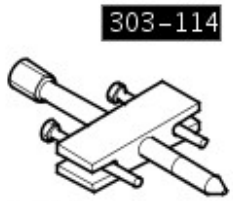
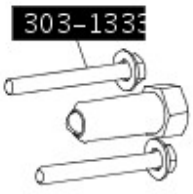
10. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

11. Carry out a fuel system leak test using the Land Rover approved diagnostic system.

12. Carry out the fuel injector calibration procedure using the Land Rover approved diagnostic system.

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Injection Pump

Removal and Installation

Special Tool(s)	
 303679	Remover/Installer, Crankshaft Oil Seal 303-679
E61755	Locking Tool, Fuel Pump Sprocket 303-1151
 E54428	Remover Crankshaft Damper Pulley 303-1149
 E91082	Remover Fuel Pump 303-1333

Removal

• WARNINGS:

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Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the accessory drive component bracket.

For additional information, refer to: Accessory Drive Component Bracket (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Remove the brake vacuum pump.
For additional information, refer to: Brake Vacuum Pump (206-07 Power Brake Actuation, Removal and Installation).

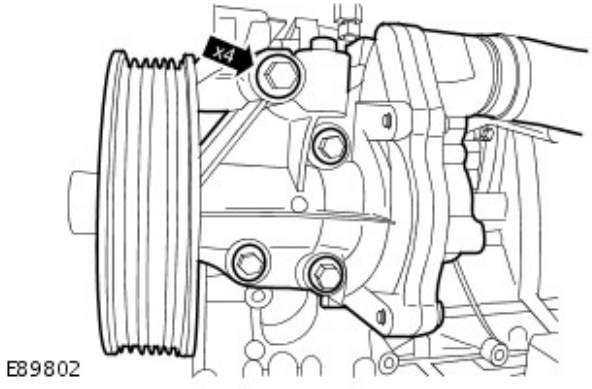
4. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

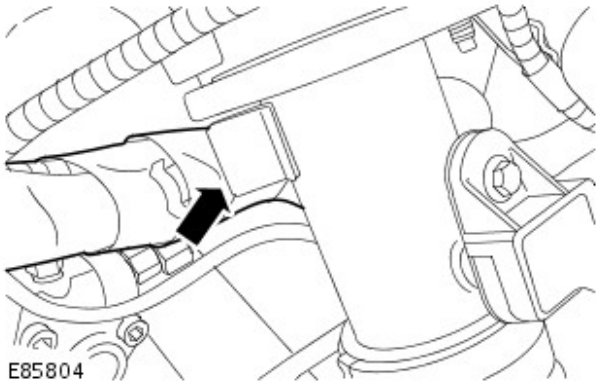
5. Drain the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

6. Release the water pump.

- Remove the 4 bolts.
- Remove and discard the gasket.



7. Release the wiring harness.

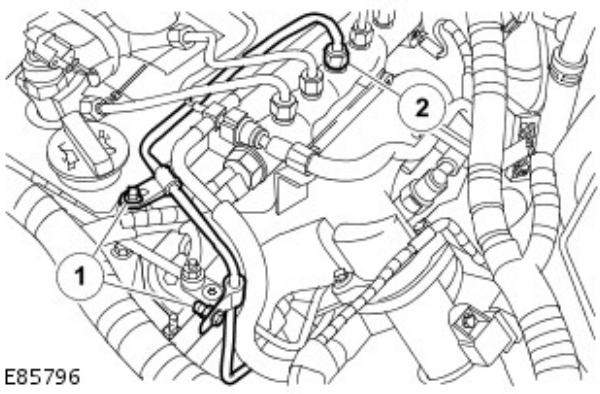


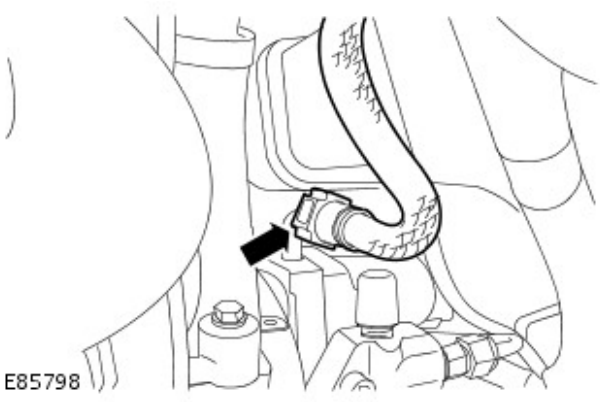
8. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

9. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Release the fuel injection pump high-pressure fuel line.

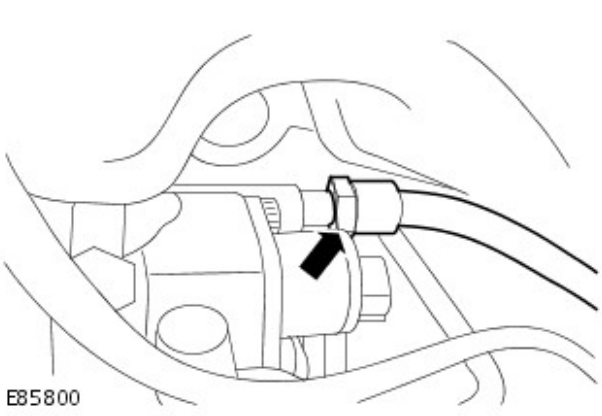
1. Remove the 2 bolts.
2. Release the fuel pump high-pressure fuel line union.





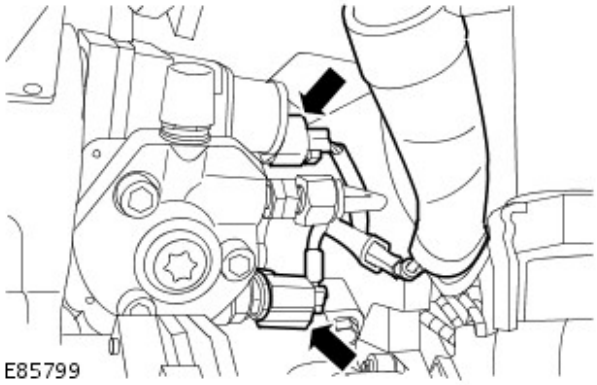
10. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the fuel injector to fuel injection pump line.

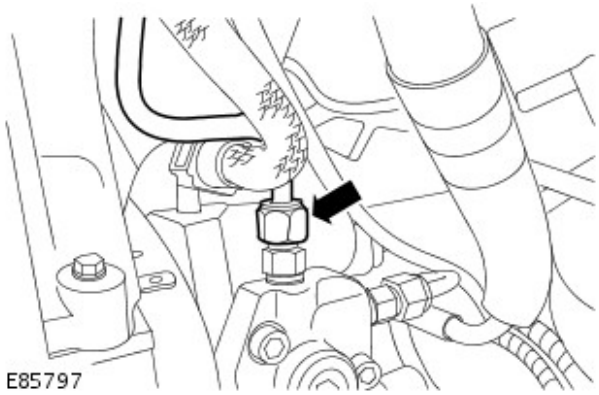


11. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the fuel return line.



12. Disconnect the fuel metering valve and the fuel temperature sensor.

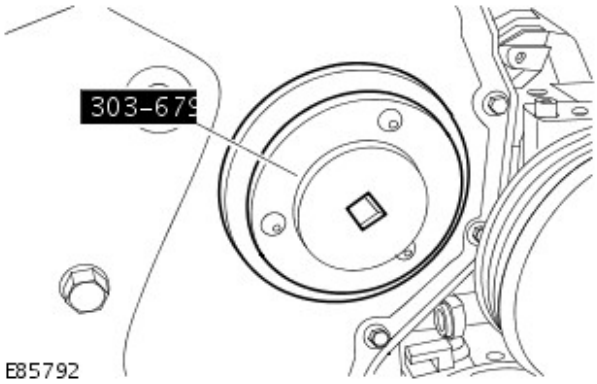


13. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

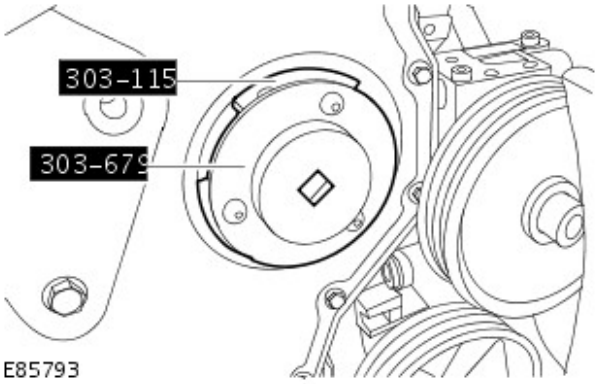
Remove and discard the fuel injection pump high-pressure fuel line.

14. Using the special tool, remove the fuel injection pump

14. Using the special tool, remove the fuel injection pump drive gear cover.

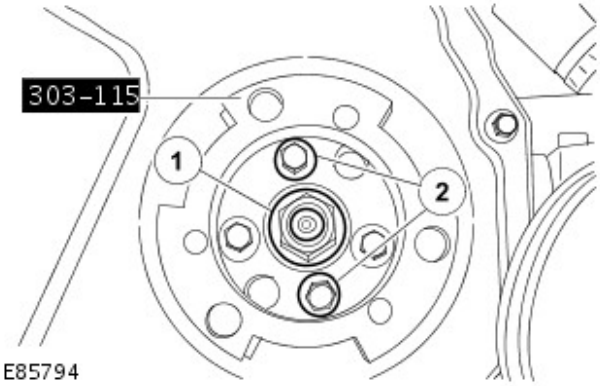


15. Install the special tools.

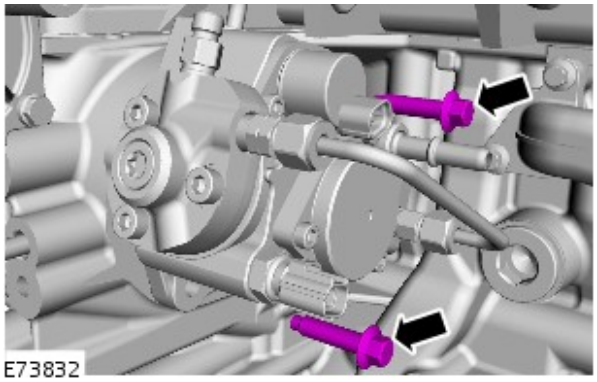


16. Release the fuel injection pump drive gear.

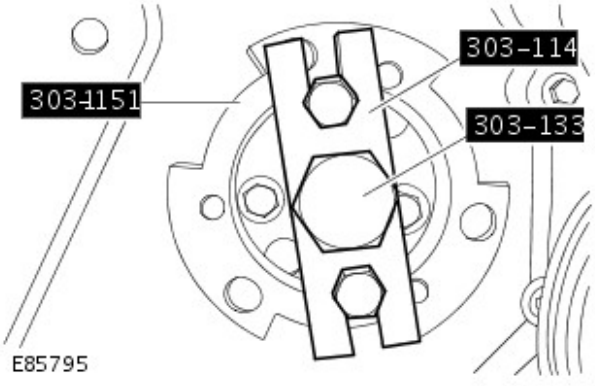
1. Remove the nut.
2. Remove the 2 bolts.



17. Remove 2 bolts from the fuel injection pump.

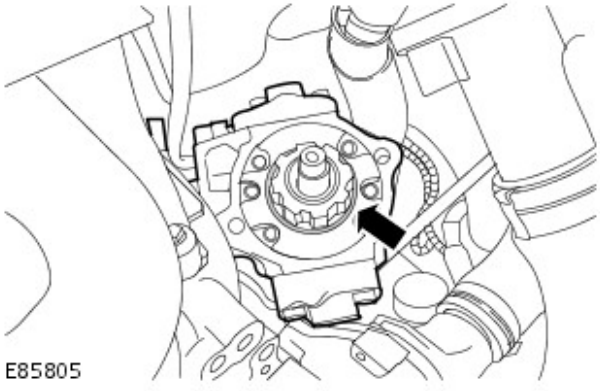


18. Using the special tool, release the fuel injection pump.



19. Remove the fuel injection pump.

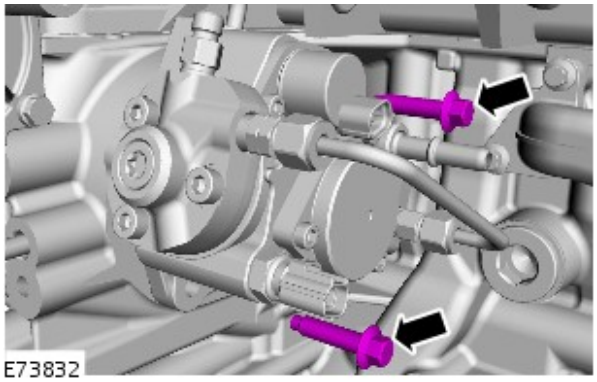
- Remove and discard the O-ring seal.



Installation

1. Install the fuel injection pump.

- Clean the component mating faces.
- Install a new O-ring seal.
- Install the fuel injection pump bolts.

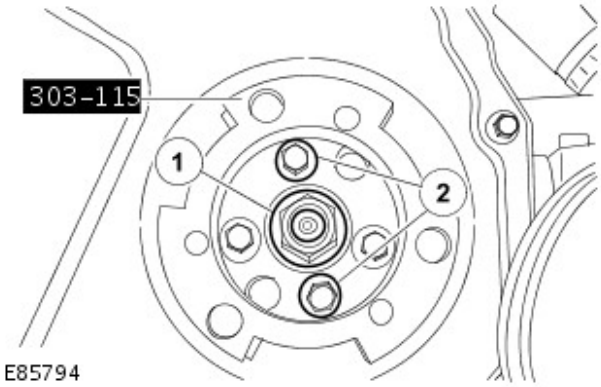


2. Secure the fuel injection pump.

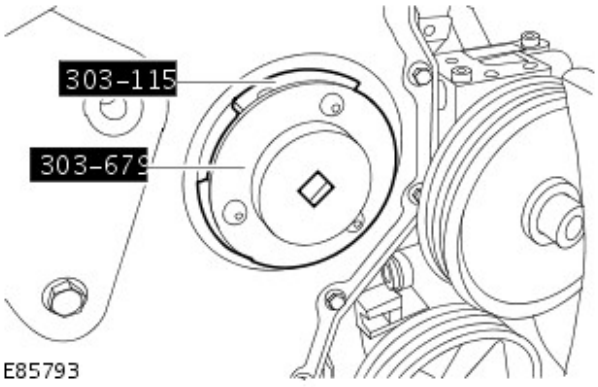
- Tighten the bolts to 23 Nm (17 lb.ft).

3. Secure the fuel injection pump drive gear.

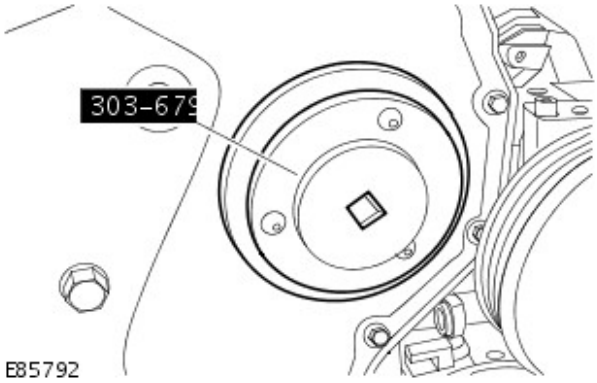
1. Tighten the nut to 64 Nm (47 lb.ft).
2. Tighten the bolts to 33 Nm (24 lb.ft).



4. Remove the special tools.



5. Using the special tool, install the fuel injection pump drive gear cover.



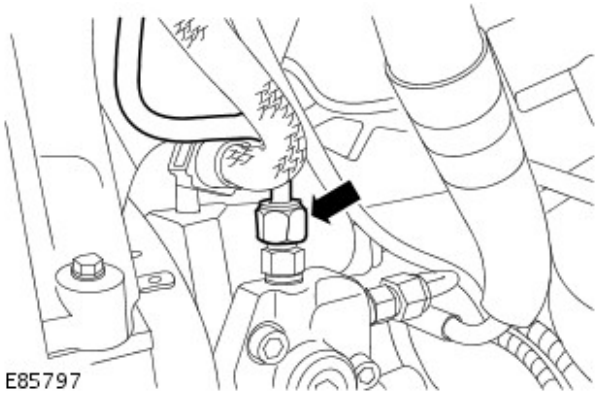
6. NOTE: Remove and discard the blanking caps.

Loosely install a new high-pressure fuel line.

- Loosely install the high-pressure pipe clamps.

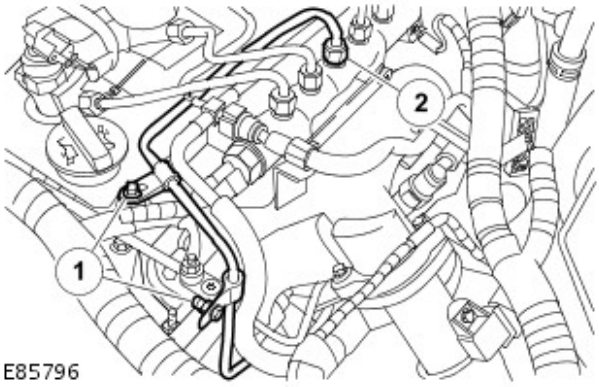
7. Install the fuel injection pump high-pressure fuel line.

- Tighten to 35 Nm (26 lb.ft).



8. Secure the fuel injection pump high-pressure fuel line.

1. Tighten to 10 Nm (7 lb.ft).
2. Tighten to 35 Nm (26 lb.ft).



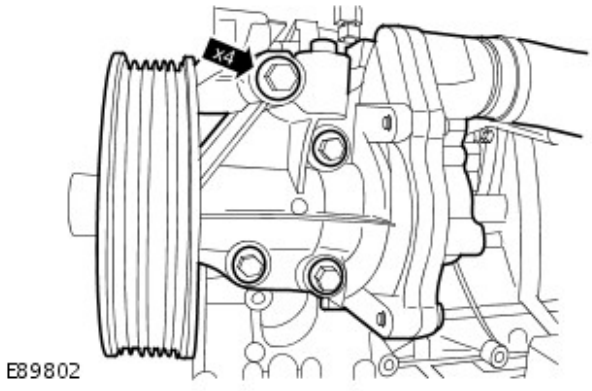
9. Connect the fuel metering valve and the fuel temperature sensor.

10. NOTE: Remove and discard the blanking caps.

Connect the fuel return line.

11. Secure the wiring harness to the inlet pipe.

12. Install the water pump.



- Install a new gasket.
- Tighten to 23 Nm (17 lb.ft).

13. Fill and bleed the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

14. Install the brake vacuum pump.
For additional information, refer to: Brake Vacuum Pump (206-07 Power Brake Actuation, Removal and Installation).

15. Install the accessory drive component bracket.
For additional information, refer to: Accessory Drive Component Bracket (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

16. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

17. Using the Land Rover approved diagnostic system carry out the fuel injection pump learn procedure.

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Metering Valve

Removal and Installation

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

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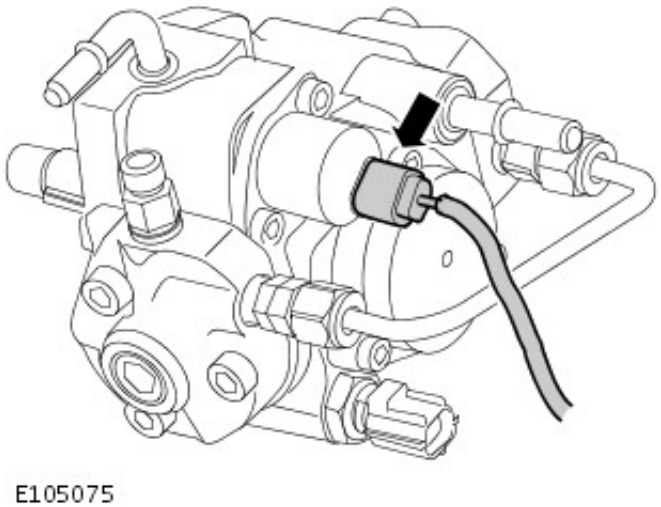
Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

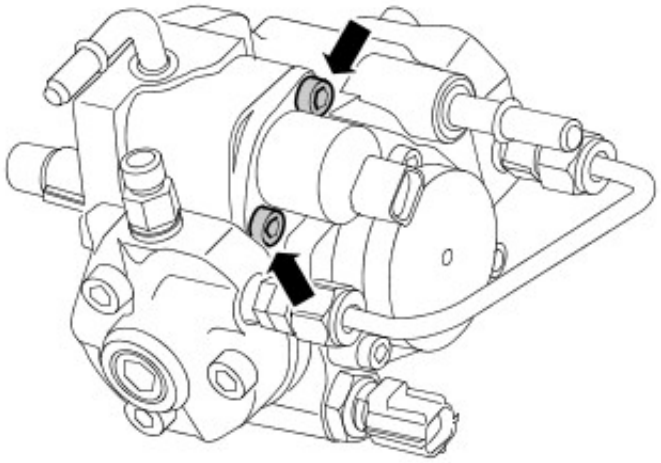
1. Open the front door.
2. Remove the front seat cushion assembly.
3. Remove the battery cover.
4. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
5. Open the bonnet.
6. Disconnect the fuel metering valve electrical connector.



E105075

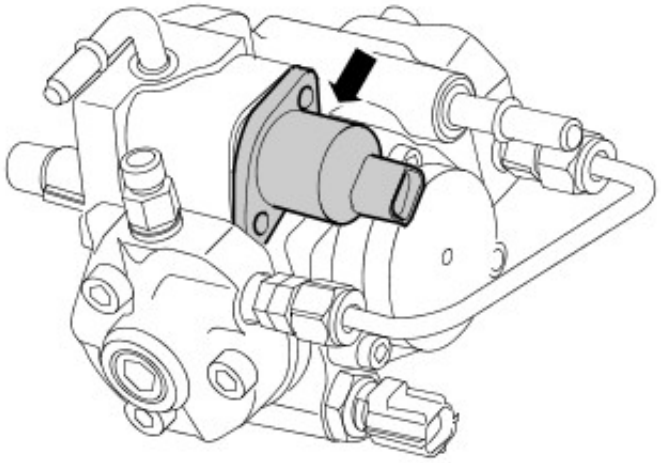
7. Remove the 2 fuel metering valve securing bolts.

7. Remove the 2 fuel metering valve securing bolts.



E105076

8. Remove the fuel metering valve.



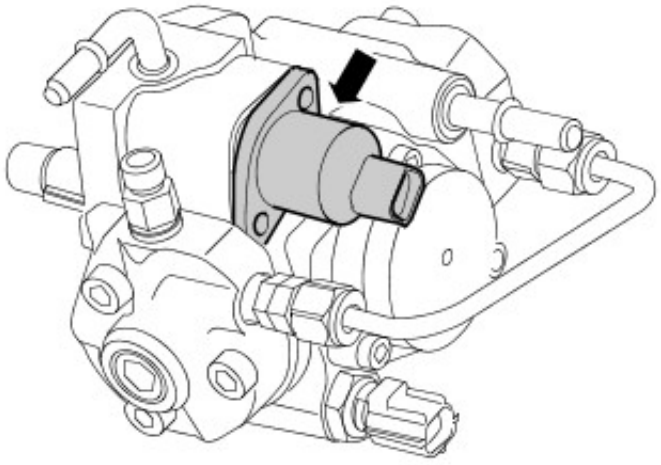
E105077

9. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Installation

1. Install the fuel metering valve with new seal and gasket.

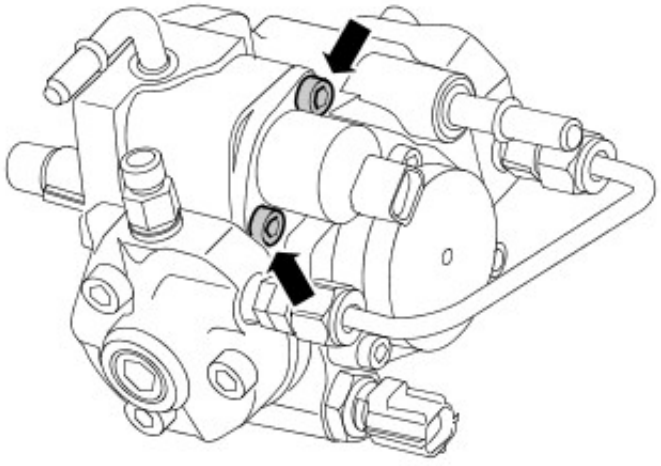
2. Install the fuel metering valve with new seal and gasket.



E105077

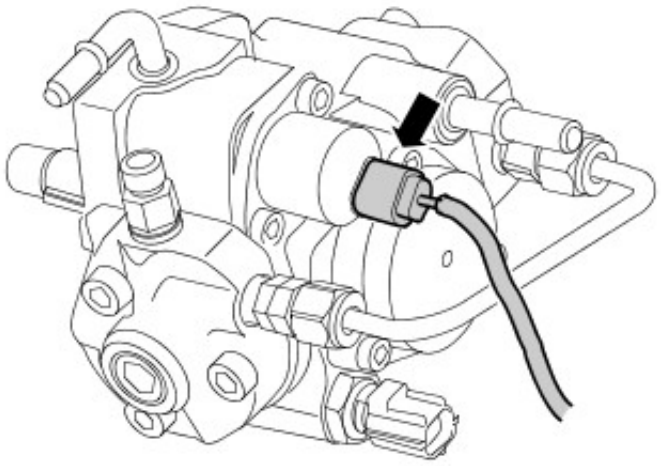
2. Install the 2 fuel metering valve securing bolts.

- Stage 1 tighten bolts to 5 Nm (4 lb.ft).
- Stage 2 tighten bolts to 8 Nm (6 lb.ft).



E105076

3. Connect fuel metering valve electrical connector.



E105075

4. Close the bonnet.

5. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).
6. Install the battery cover.
7. Install the front seat cushion assembly.
8. Close the front door.
9. Using the Land Rover approved diagnostic system carry out the pump learn procedure found in the set-up and configuration section.

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Pressure Relief Valve

Removal and Installation

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

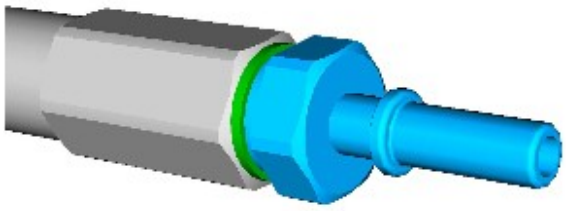
If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

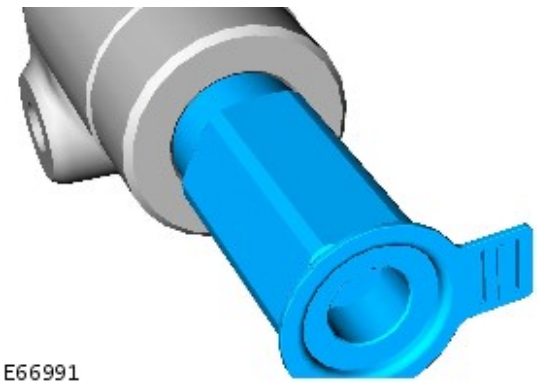
CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
   For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
3. Remove the fuel spigot.



E87930

4. Remove and discard the fuel pressure relief valve.



E66991

E66949

5. CAUTION: Make sure no damage to the fuel rail the mating faces occurs. Failure to follow this instruction may result in damage to the components.

Remove and discard the gasket.

Installation

E66949

1. CAUTION: Make sure no damage to the fuel rail the mating faces occurs. Failure to follow this instruction may result in damage to the components.

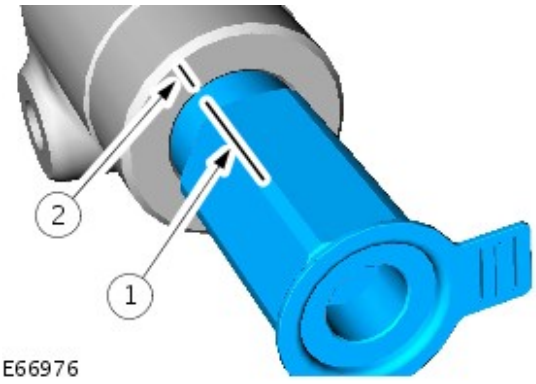
Install a new gasket.

- Clean the component mating faces.

E66991

2. Install a new fuel pressure relief valve.

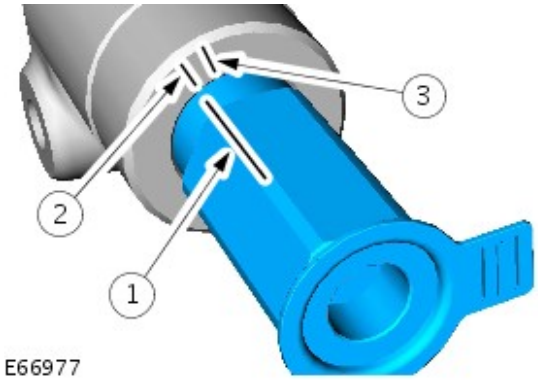
- Tighten to 30 Nm (22 lb.ft).



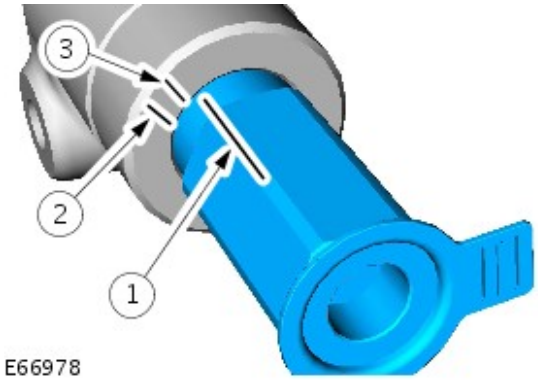
E66976

3. Draw a line on the corner of the fuel pressure relief valve (1) and on the side of the fuel rail (2).

4. Draw a line (3) 3 mm (0.11 inches) from line (2)



E66977



E66978

5. Tighten the fuel pressure relief valve and make sure that line (1) passes line (3).

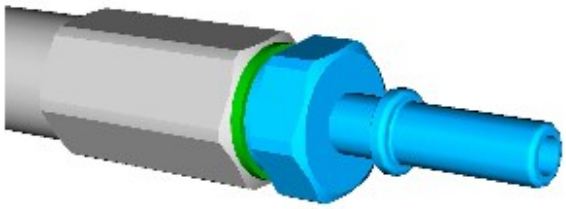
- Tighten to 172 Nm (127 lb.ft).

6. If line (1) does not pass line (3) remove the fuel pressure relief valve and inspect for contamination and thread damage to the fuel rail. Reassemble from step 2.

7. NOTE: Remove and discard the blanking caps.

Install the fuel spigot.

- Clean the component mating faces.
- Tighten to 20 Nm (15 lb.ft).


E87930

8. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

9. Carry out a fuel system leak test using the Land Rover approved diagnostic system.

Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Rail

Removal and Installation

General Equipment

Pneumatic vacuum gun

Removal

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

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If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

• CAUTIONS:

Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

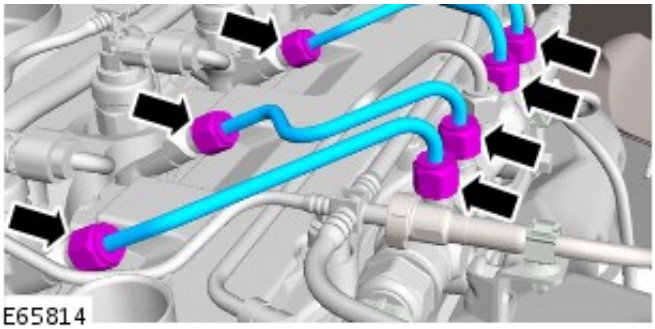
Always carry out the cleaning process before carrying out any repairs to the fuel injection system components. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

Do not disconnect the fuel injector electrical connectors with the engine running. Failure to follow this instruction may result in serious damage to the engine.

Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the engine cover.
   For additional information, refer to: Engine Cover (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Using the pneumatic vacuum gun, vacuum foreign material from the high-pressure fuel supply lines, the fuel rails and the fuel injection pump.
   For additional information, refer to: Fuel Injection Component Cleaning (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
4. CAUTIONS:

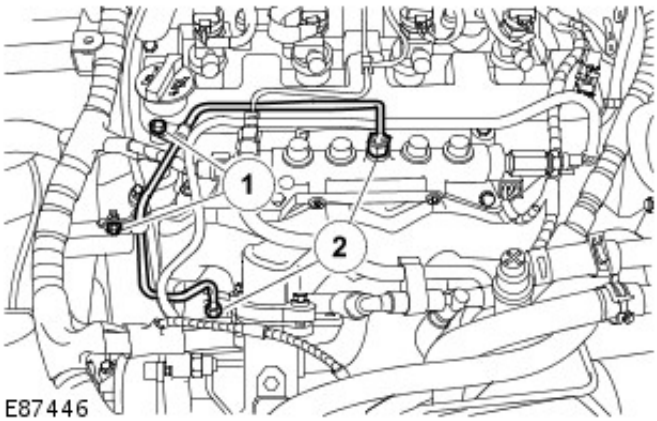
Do not allow the unions to hit the olive ends of the high-



pressure fuel supply line as this may damage the ends of the line and allow foreign matter to enter the fuel injection system.

Make sure that all openings are sealed. Use new blanking caps.

Remove and discard the 4 high-pressure fuel supply lines.



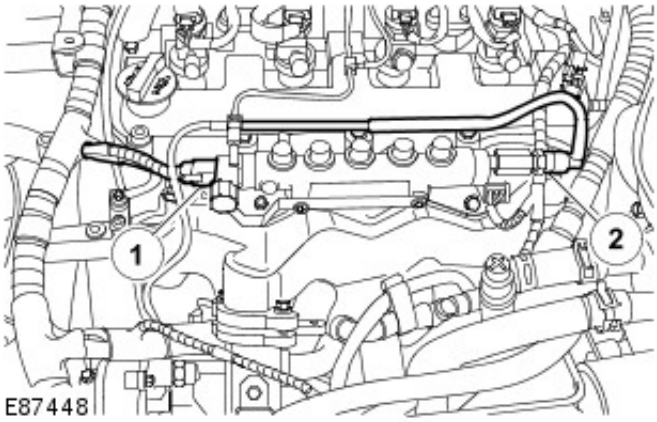
5. CAUTIONS:

Do not allow the unions to hit the olive ends of the high-pressure fuel supply line as this may damage the ends of the line and allow foreign matter to enter the fuel injection system.

Make sure that all openings are sealed. Use new blanking caps.

Remove and discard the high-pressure fuel rail supply line.

1. Release the clips.
2. Remove the high-pressure fuel rail supply line.



6. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

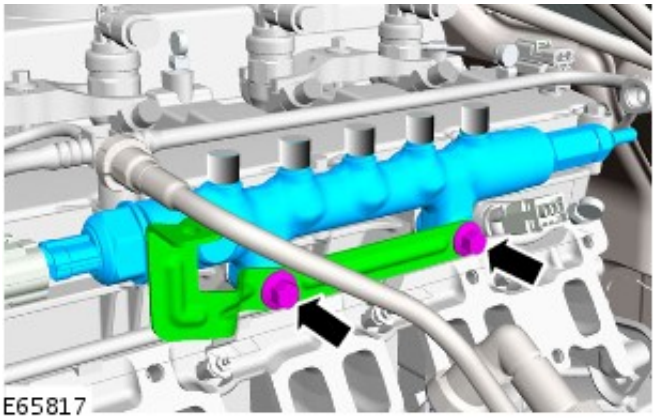
Disconnect the fuel rail pressure (FRP) sensor electrical connector and fuel return line.

1. Disconnect the FRP sensor electrical connector.
2. Disconnect the fuel rail return line.

7. Remove the intake manifold.
For additional information, refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

8. Remove the fuel rail.

- Remove the 2 bolts.
- Remove the bracket.



Installation

- WARNINGS:

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Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

Do not carry out any repairs to the fuel system with the engine running. The fuel pressure within the system can be as high as 2000 bar (29,008 lb-sq-in). Failure to follow this instruction may result in personal injury.

• CAUTIONS:

Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install new blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

Always carry out the cleaning process before carrying out any repairs to the fuel injection system components. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

Do not disconnect the fuel injector electrical connectors with the engine running. Failure to follow this instruction may result in serious damage to the engine.

Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

1. CAUTION: Only tighten the bolts finger-tight at this stage.

• NOTE: Clean the component mating faces.

Install the fuel rail.

- Install the bracket.
- Loosely install the bolts.

2. CAUTIONS:

Maintain pressure on the high-pressure fuel supply line to keep the olives in contact with the fuel injectors and the fuel rail cones while installing unions.

Do not allow the unions to hit the olive ends of the high-pressure fuel supply line as this may damage the ends of the high-pressure fuel supply line and allow foreign matter to enter the fuel injection system.

Only tighten the unions finger-tight at this stage.

• NOTE: Remove and discard the blanking caps.

Loosely install the new high-pressure fuel rail supply line.

3. CAUTIONS:

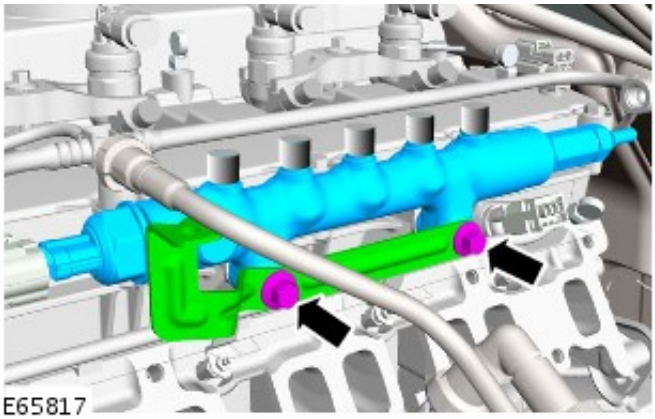
Maintain pressure on the high-pressure fuel supply line to keep the olives in contact with the fuel injectors and the fuel rail cones while installing unions.

Do not allow the unions to hit the olive ends of the high-pressure fuel supply line as this may damage the ends of the high-pressure fuel supply line and allow foreign matter to enter the fuel injection system.

Only tighten the unions finger-tight at this stage.

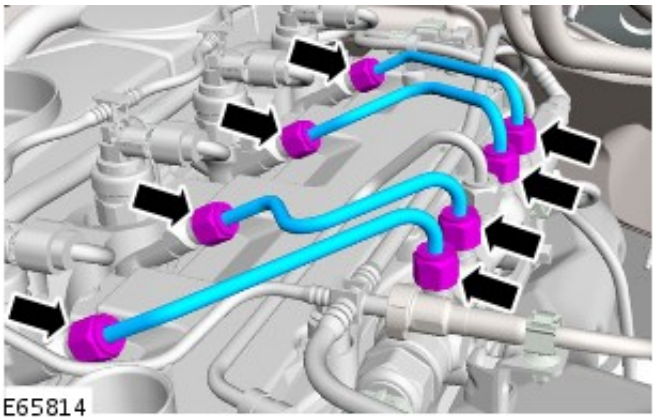
• NOTE: Remove and discard the blanking caps.

Loosely install the new high-pressure fuel supply lines.


E65817

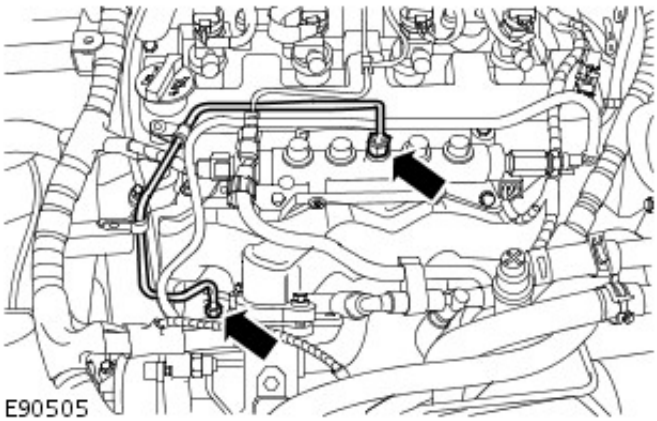
4. Secure the fuel rail.

- Stage 1: Tighten the bolts to 8 Nm (6 lb.ft).
- Stage 2: Tighten the bolts to 23 Nm (17 lb.ft).


E65814

5. Secure the high-pressure fuel supply lines.

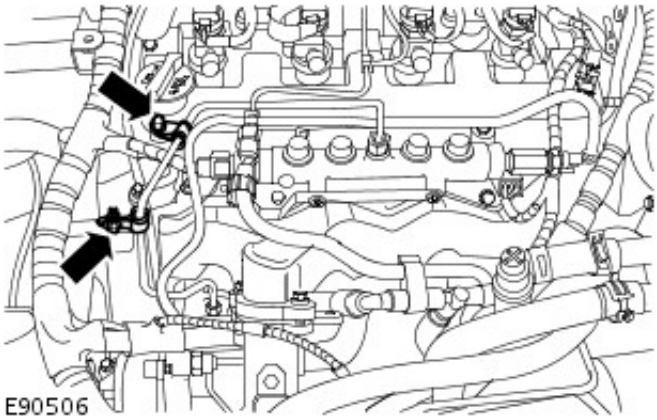
- Stage 1: Tighten the unions to 5 Nm (4 lb.ft).
- Stage 2: Tighten the unions to 35 Nm (26 lb.ft).


E90505

6. Secure the high-pressure fuel rail supply line.

- Stage 1: Tighten the unions to 5 Nm (4 lb.ft).
- Stage 2: Tighten the unions to 35 Nm (26 lb.ft).

7. Tighten to 10 Nm (7 lb.ft).



8. Install the intake manifold.
For additional information, refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

9. Connect the FRP sensor electrical connector.

10. NOTE: Remove and discard the blanking caps.

Connect the fuel return line.

11. Install the engine cover.
For additional information, refer to: Engine Cover (501-05 Interior Trim and Ornamentation, Removal and Installation).

12. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

13. Carry out a fuel system leak test using the Land Rover approved diagnostic system.

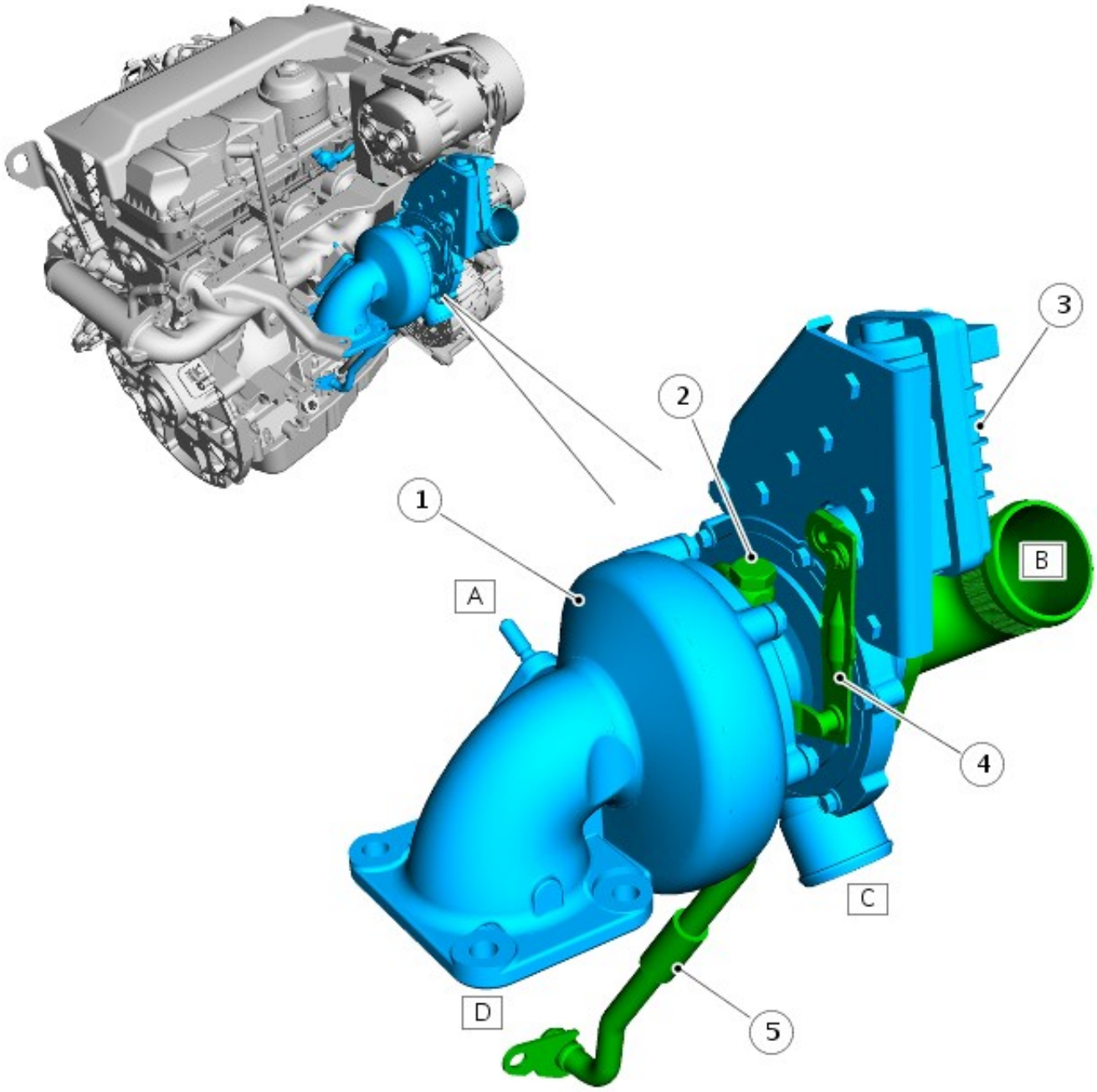
Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Turbocharger inlet duct bolts	23	17
Turbocharger nuts	23	17
Turbocharger oil return tube	10	7
Turbocharger oil supply pipe	35	26
Catalytic converter nuts	45	33
Catalytic converter lower mounting bracket bolts	30	22
Front muffler to catalytic converter nuts	30	22
Turbocharger mounting bracket	20	15
Turbocharger heat shield	10	7
Turbocharger to charge air cooler clip	3	2

Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Turbocharger

Description and Operation

COMPONENT LOCATION



E86485

Item	Part Number	Description
A	-	Exhaust manifold connection
B	-	Intake air connection
C	-	Charge air cooler connection
D	-	Exhaust pipe connection
1	-	Turbine housing
2	-	Oil feed
3	-	Actuator motor
4	-	Actuator lever
5	-	Oil return

OVERVIEW

The variable vane turbocharger, fitted to the exhaust manifold, makes it possible to vary the exhaust gas flow of the turbine, dependent on engine operation. This improves the power transfer to the turbine wheel and compressor, particularly at low engine speeds, thus increasing the boost pressure. The guide vanes are opened progressively as the engine speed increases so that the power transfer always remains in balance with the required charger speed and the required boost pressure level. Variable vanes facilitate better use of the exhaust gas energy so as to further improve the efficiency of the turbocharger and thus of the engine, compared to the more conventional 'wastegate control'.

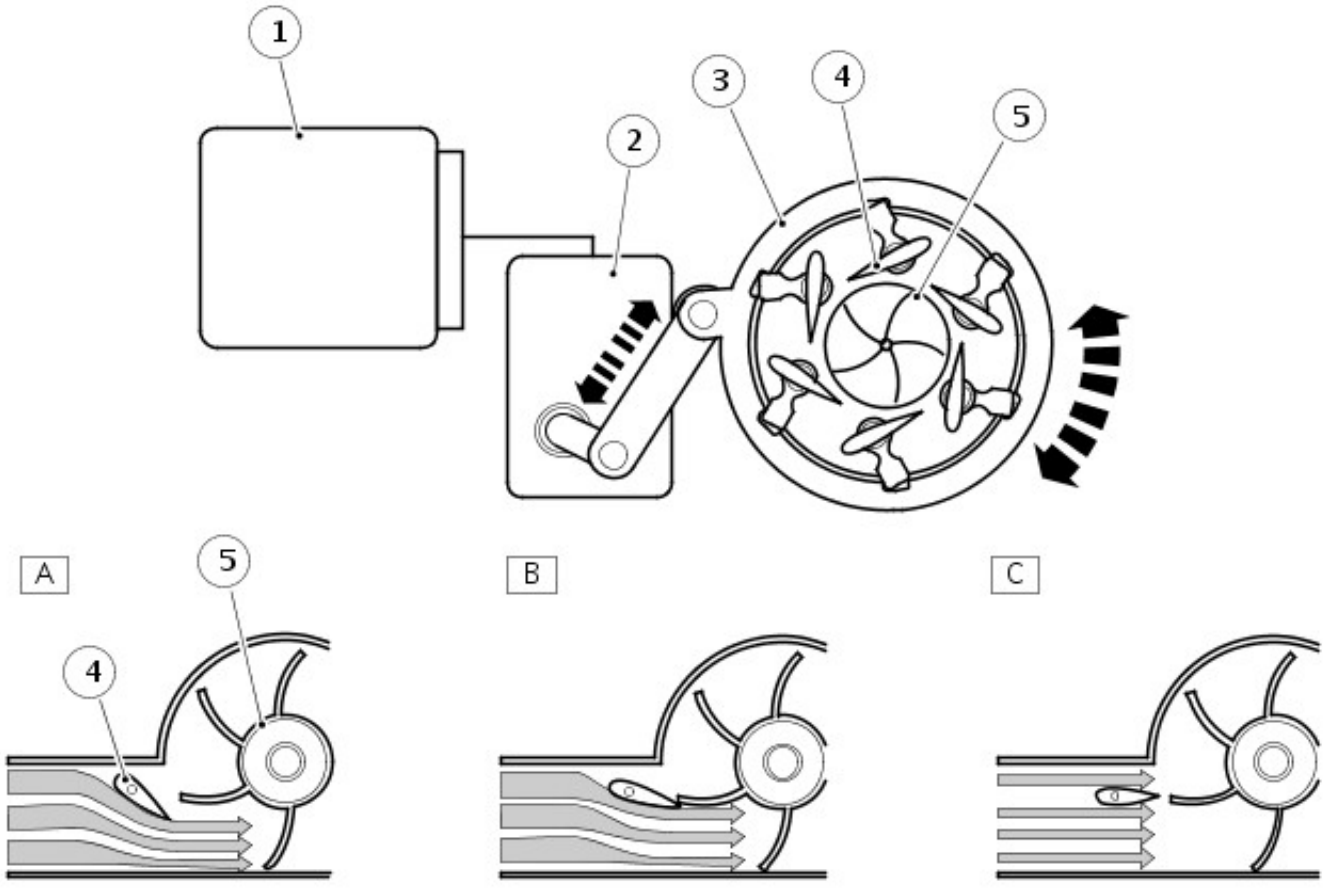
Advantages:

- High torque at both high and low engine speeds
- Continuous and optimum adjustment for all engine speeds
- No wastegate valve required, exhaust energy is better utilised, less back-pressure in conjunction with same compressor work
- Low thermal and mechanical load improves engine power output
- Lower emissions
- Optimised fuel consumption over the entire engine speed range

A Direct Current (DC) rotary actuator motor operates a drive shaft. The drive shaft is connected to the vanes by an actuating lever. Adjustment of the vanes is achieved by moving the actuating lever. When the drive shaft is turned, a signal is created at the end of the drive shaft; this feedback signal is used to determine the angular position of the vanes. This information is transmitted to the Engine Control Module (ECM).

The turbocharger is designed for fail safe operation. If a fault occurs regarding the control of the unit, the vanes default to the fully open position so as to produce minimum boost. The ECM detects any malfunctions in the stepper motor and generates Diagnostic Trouble Codes (DTC).

PRINCIPLES OF OPERATION



E80503

Item	Part Number	Description
A	-	Low engine speed
B	-	Moderate engine speed
C	-	Maximum engine speed
1	-	ECM
2	-	Actuator motor
3	-	Adjusting ring
4	-	Vanes

5	-	Turbine

A - Low Engine Speed

At low engine speeds the volume of exhaust gas is low so the vanes are moved towards the closed position to reduce the turbine inlet area. This reduction causes an increase in the gas velocity into the turbine wheel thereby increasing wheel speed and boost.

B - Moderate Engine Speed

As the engine speed increases and the volume of exhaust gas increases the vanes are moved towards the open position to increase the turbine inlet area and maintain the gas velocity.

C - Maximum Engine Speed

At maximum engine speed the vanes are almost fully open maintaining the gas velocity into the turbine wheel.

Barometric Pressure Sensor

When the vehicle is driven at high altitudes the ambient pressure reduces causing the compressor wheel to do less work for the same boost pressure. To prevent the turbine wheel from over-speeding under these conditions a barometric pressure sensor, located in the ECM, protects the turbocharger by opening the vanes further to reduce the turbine wheel speed. This is known as the altitude margin of the turbocharger.

Turbocharger Lubrication

The rapid acceleration and deceleration response demands of the turbocharger rely greatly on a steady flow of clean oil. The oil supplied from the engine's lubrication system provides lubrication to the turbocharger's spindle and bearings, while also acting as a coolant for the turbocharger centre housing.

To maintain the life expectancy of the turbocharger, it is essential that the oil has a free-flow through the turbocharger and unrestricted return to the engines sump. It is therefore imperative that the engine oil is replenished at regular service intervals with the recommended quality and quantity of oil.

Charge Air Cooler

The charge air cooler is used to increase the density of air as it flows from the turbocharger compressor to the intake manifold.

Compression of the charge air by the turbocharger raises the temperature of the air. This generation of heat expands the air density and consequently less oxygen is able to enter the cylinders, reducing the engines power. To overcome this, the air is routed through the charge air cooler before it enters the engine; the temperature is reduced by transferring the heat to atmosphere.

Cooling of the intake air also helps to reduce engine emissions by limiting nitrogen oxides (NOx) production.

Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Turbocharger

Diagnosis and Testing

Overview

For information on description and operation:
REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

1. • WARNINGS:

   The following tests may involve working in close proximity to hot components. Make sure adequate protection is used. Failure to follow this instruction may result in personal injury.

   The turbocharger can continue to rotate after the engine has stopped. Do not attempt to check the turbocharger until one minute has elapsed since the engine was switched off. Failure to follow this instruction may result in personal injury.

   1. Verify the customer concern.

2. **2.** Visually inspect for obvious mechanical or electrical faults.

Visual Inspection Chart

Mechanical	Electrical
• Intake air system • Hose(s)/hose connections • Turbocharger • General engine condition.	• Circuit(s) • Electrical connections and harnesses • Turbocharger actuator • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.

   - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible source	Action
Poor performance (off-boost)	• Low/contaminated fuel • Restricted intake air system • General engine condition • Engine control module (ECM) failure	Check the fuel level and condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for restriction. Check the engine condition, compressions, etc. if there are indications of a mechanical fault. Check for DTCs indicating a module fault. Refer to the warranty policy and procedures manual if an ECM is suspect.
No boost	• Electrical connections and harnesses • Restricted intake air system • Charge air cooler restricted/leaking • Turbocharger actuator failure • Turbocharger failure • Engine control module (ECM) failure	Check the electrical connections and harnesses. Check the intake air system for restriction/leakage. Check the turbocharger actuator and circuits. Refer to the electrical guides. Check the turbocharger for wear. Disconnect the turbocharger intake and outlet pipework and turn the turbocharger by hand. Any roughness indicates a fault. Check any up and down movement in the turbocharger shaft. Excessive movement indicates a fault. If in doubt, compare the suspect unit with a new turbocharger. Check for DTCs indicating an actuator or module fault. Refer to the warranty policy and procedures manual if an ECM is suspect.
No boost/excessive noise	• Turbocharger failure	Disconnect the turbocharger intake and outlet pipework and turn the turbocharger by hand. Any roughness indicates a fault. Check any up and down movement in the turbocharger shaft. Excessive movement indicates a fault. If in doubt, compare the suspect unit with a new turbocharger.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible causes	Actions
P004611	Turbocharger boost control A circuit range/performance - circuit short to ground	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger fault	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P004612	Turbocharger boost control A circuit range/performance - circuit short to battery	• Turbocharger control solenoid circuit: short circuit to power • Turbocharger fault	
P00461A	Turbocharger boost control A circuit range/performance - circuit resistance below threshold	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger control solenoid circuit: short circuit to power • Turbocharger control solenoid circuit: open circuit • Turbocharger fault	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P00461B	Turbocharger boost control A circuit range/performance - circuit resistance above threshold	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger control solenoid circuit: short circuit to power	

		• Turbocharger control solenoid circuit: open circuit • Turbocharger fault	
P006900	Manifold absolute pressure (MAP) sensor - barometric pressure correlation	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • NOTE: Barometric pressure sensor is part of the engine control module (ECM) • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault • Barometric pressure sensor fault	Check for related DTCs. Rectify as necessary. Using a data logger function check the barometric and manifold absolute pressure readings, both sensors should read approximately atmospheric pressure (ignition on, engine NOT running). A reading significantly higher or lower on one sensor would indicate a sensor fault. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and check for normal operation. Refer to the warranty policy and procedures manual, if a module is suspect.
P006A00	Manifold absolute pressure (MAP) sensor - mass or volume air flow correlation	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • Restricted air intake path • Exhaust gas recirculation (EGR) valve stuck open • Turbocharger fault • MAP sensor fault • Mass air flow (MAF) sensor fault	Check the intake air path for restrictions. Rectify as necessary. Check for DTCs indicating an EGR, turbocharger, MAPT or MAF sensor fault. Rectify as necessary. Clear the DTCs and check for normal operation.
P00952F	Intake air temperature (IAT) sensor 2 circuit - signal erratic	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2 circuit: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

P009511	Intake air temperature (IAT) sensor 2 circuit - circuit short to ground	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009515	Intake air temperature (IAT) sensor 2 circuit - circuit short to battery or open	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010029	Mass or volume air flow A circuit - signal invalid	• Restricted air intake path • Check for leak between mass air flow (MAF) sensor and turbocharger • MAF sensor fault • Turbocharger fault • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks, restrictions, etc.. Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation.
P023400	Turbocharger A over boost condition	• Turbocharger circuit fault • Turbocharger fault • Engine control module (ECM) fault	Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger vanes etc.. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P023521	Turbocharger boost sensor A circuit - signal amplitude less than minimum	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	
P023522	Turbocharger boost sensor A	• NOTE: The MAP sensor is part of the	

	circuit - signal amplitude greater than maximum	manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	Check the MAPT sensor and circuit. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02352F	Turbocharger boost sensor A circuit - signal erratic	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	
P029900	Turbocharger A under boost condition	• Turbocharger circuit fault • Turbocharger fault • Engine control module (ECM) fault	Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger vanes etc. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P256234	Turbocharger boost control position sensor A circuit - signal high time less than minimum	• Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256235	Turbocharger boost control position sensor A circuit - signal high time greater than maximum	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256236	Turbocharger boost control position sensor A	• Turbocharger boost control position	

	circuit - signal frequency too low	sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	Check turbocharger sensor and circuit. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P256237	Turbocharger boost control position sensor A circuit - signal frequency too high	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P25632F	Turbocharger boost control position sensor A circuit range/performance - signal erratic	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256372	Turbocharger boost control position sensor A circuit range/performance - actuator stuck open	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control	Check turbocharger sensor and circuit. Refer to the electrical guides.

		position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P256373	Turbocharger boost control position sensor A circuit range/performance - actuator stuck closed	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	

Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Turbocharger

Removal and Installation

Removal

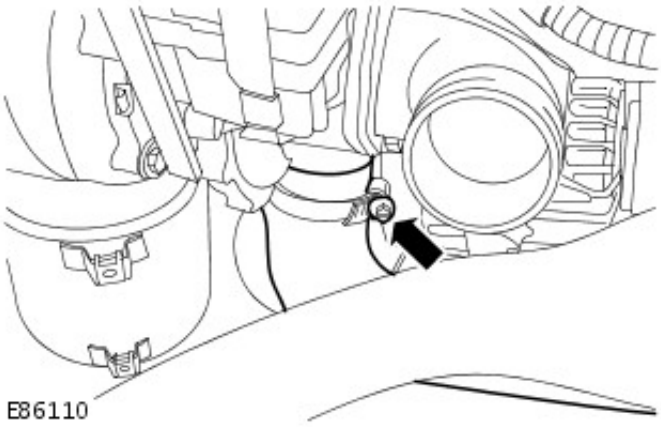
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

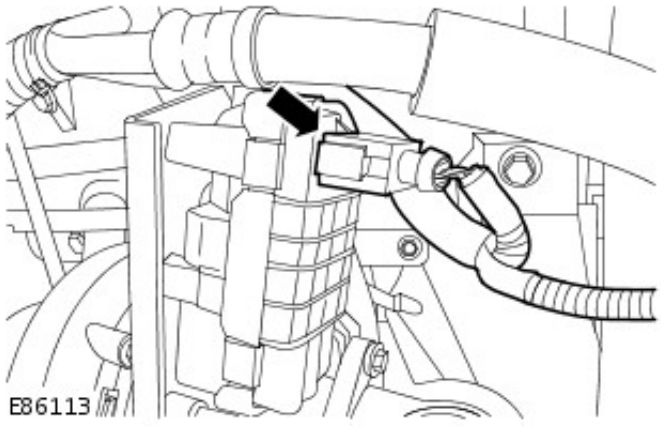
2. Remove the air cleaner outlet pipe.
For additional information, refer to: Air Cleaner Outlet Pipe (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Disconnect the charge air cooler inlet hose.

- Release the clip.

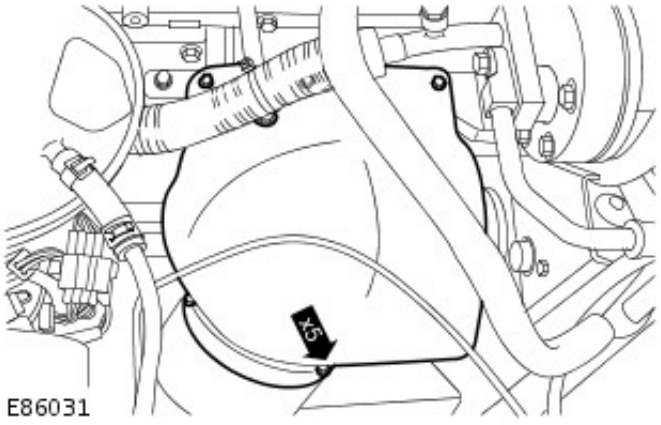


4. Disconnect the turbocharger electrical connector.



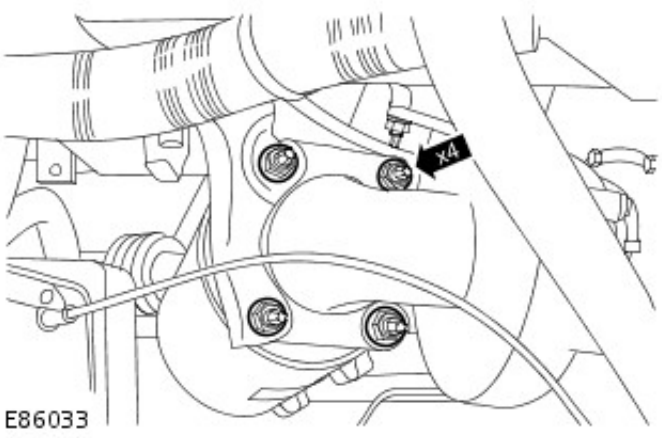
5. Remove the turbocharger heat shield.

- Remove the 5 bolts.

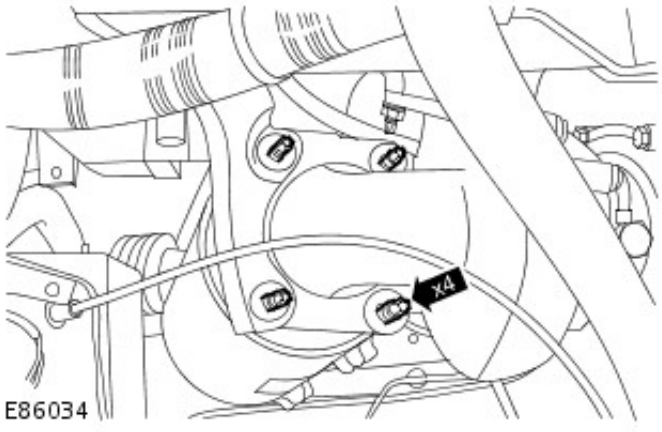


6. Remove and discard the 4 nuts from the catalytic

converter.

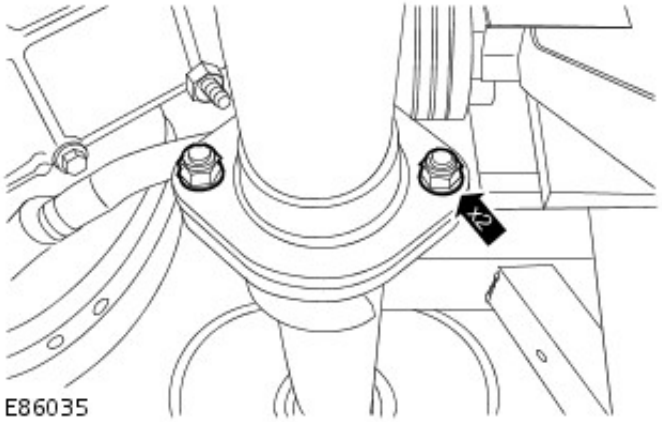


7. Remove and discard the 4 studs from the catalytic converter.



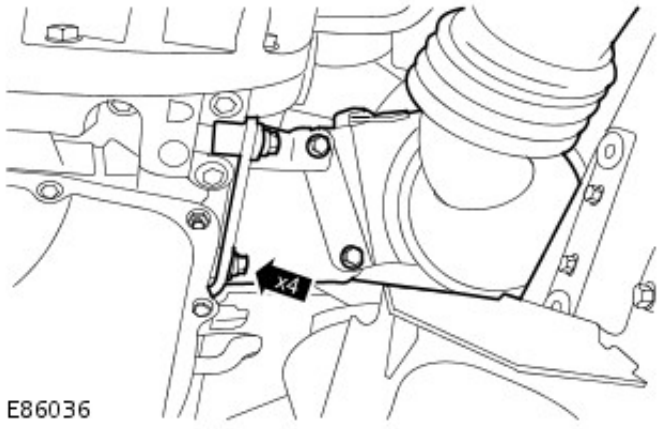
8. Release the catalytic converter.

- Remove and discard the 2 nuts.

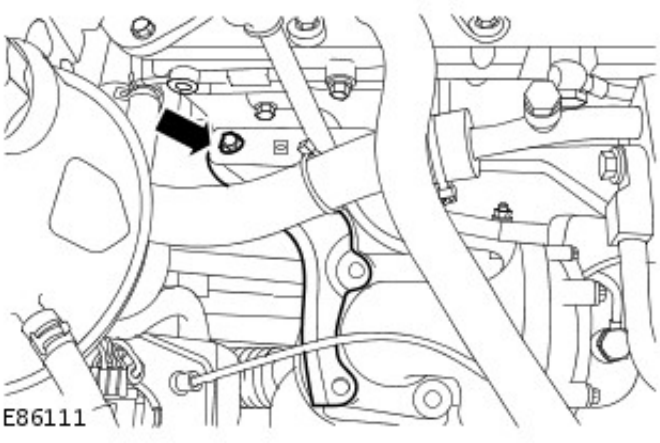


9. Release the catalytic converter.

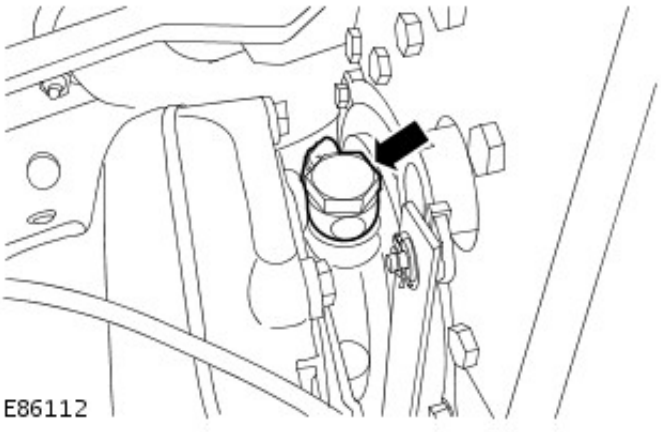
- Loosen the 4 bolts.



10. Remove the catalytic converter bracket.



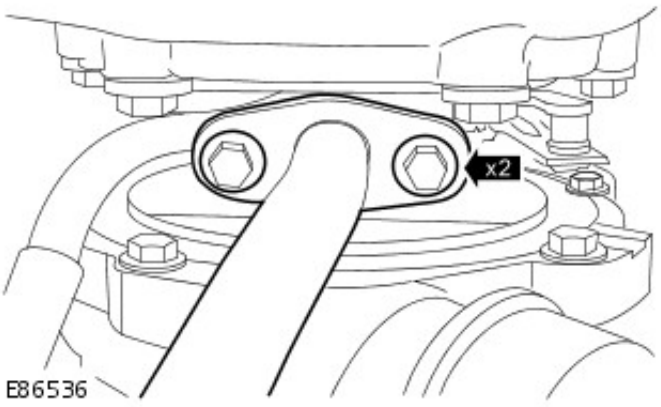
- Remove the bolt.



11. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the turbocharger oil supply pipe.

- Remove the banjo bolt.
- Remove and discard the sealing washers.

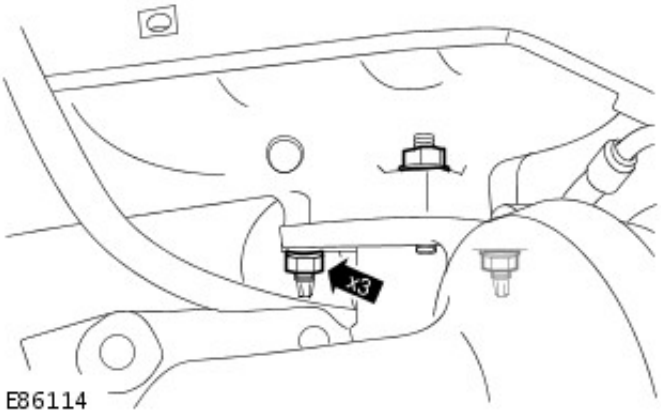


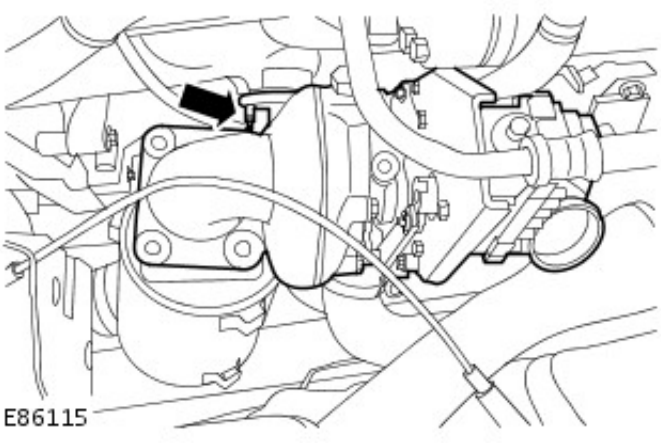
12. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Release the turbocharger oil return tube.

- Remove the 2 bolts.
- Remove and discard the gasket.

13. Remove and discard the 3 turbocharger nuts.

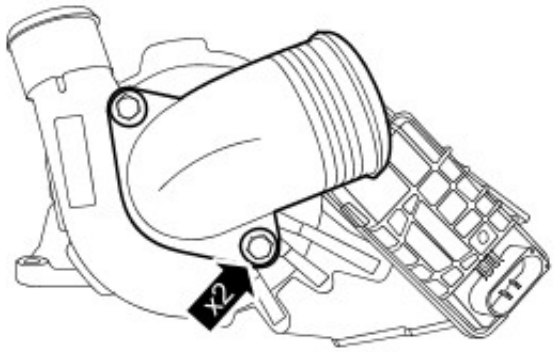



E86115

14. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the turbocharger.

- Remove and discard stud.
- Remove and discard the gasket.


E86116

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

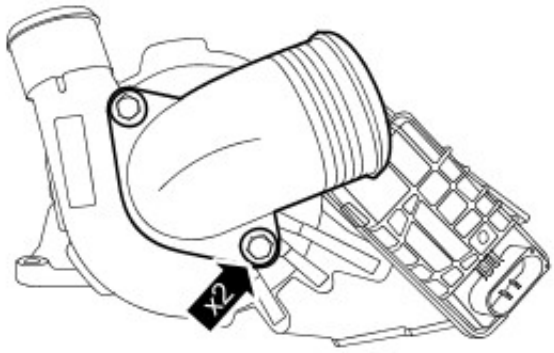
Remove the turbocharger inlet duct.

- Remove the 2 bolts.

Installation

1. Install the turbocharger inlet duct.

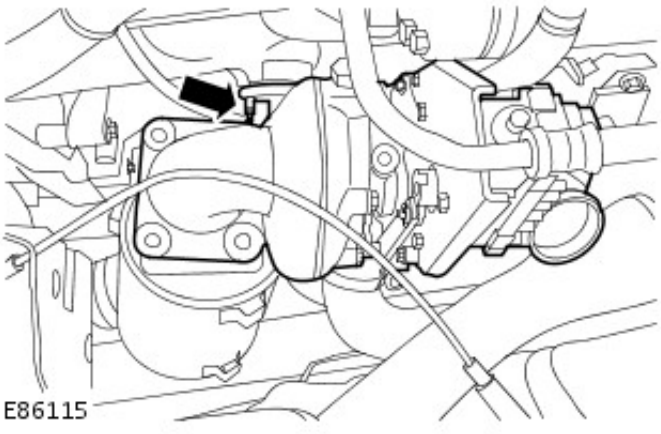
- Tighten to 23 Nm (17 lb.ft).


E86116

2. NOTE: Remove and discard the blanking caps.

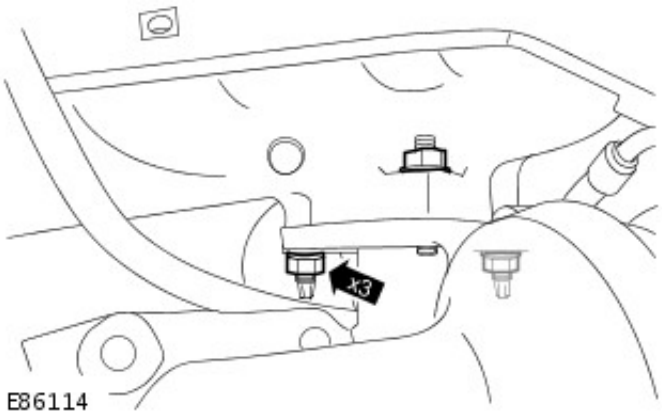
Install the turbocharger.

- Install a new gasket.
- Install new studs.


E86115

3. Install new turbocharger nuts.

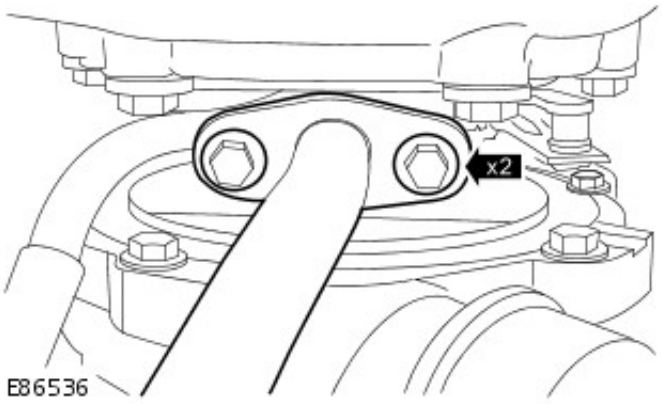
- Tighten the nut to 23 Nm (17 lb.ft).



4. NOTE: Remove and discard the blanking caps.

Secure the turbocharger oil return tube.

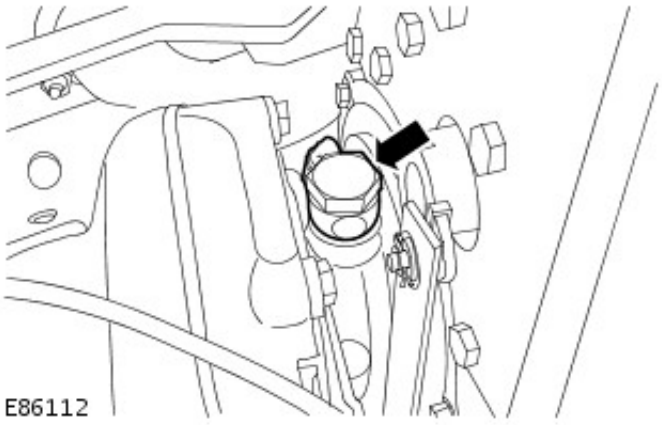
- Install a new gasket.
- Tighten the bolts to 10 Nm (7 lb.ft).



5. NOTE: Remove and discard the blanking caps.

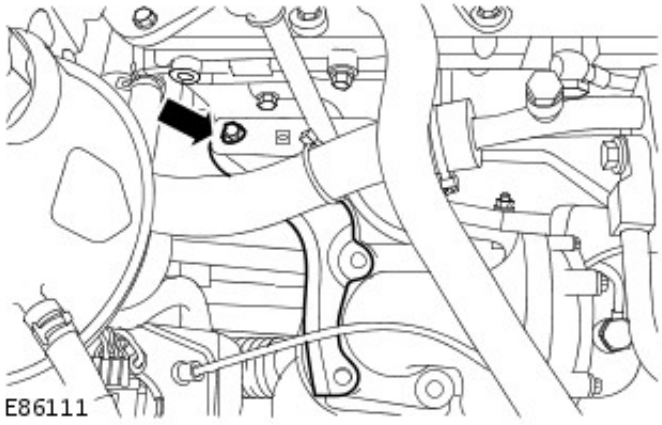
Connect the turbocharger oil supply pipe.

- Install new sealing washers.
- Tighten the banjo bolt to 35 Nm (26 lb.ft).

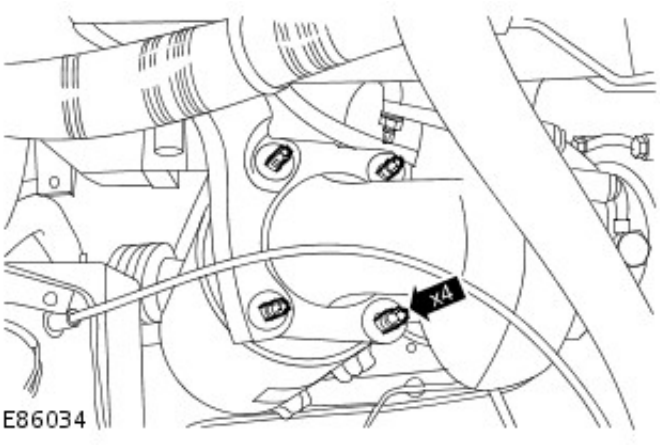


6. Install the catalytic converter bracket.

- Loosely install the bolt.

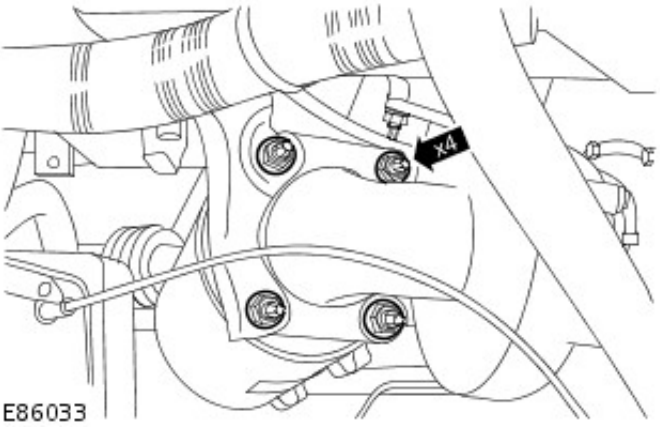


7. Install 4 new studs to the catalytic converter.

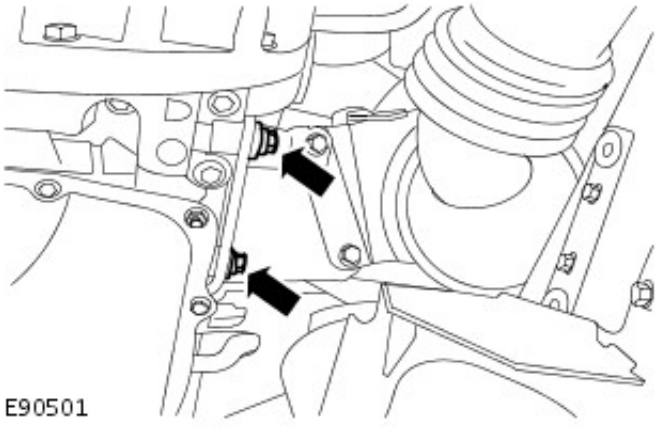


8. Install 4 new nuts to the catalytic converter.

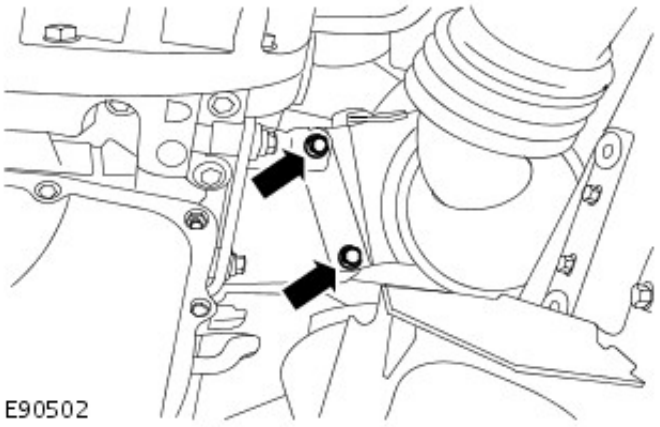
- Tighten to 45 Nm (33 lb.ft).



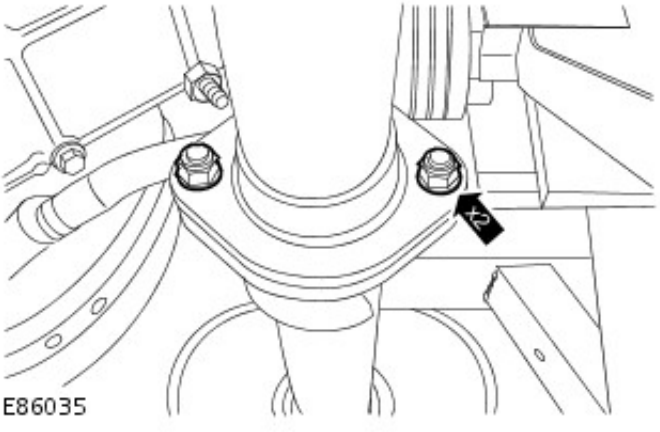
9. Tighten to 30 Nm (22 lb.ft).



10. Tighten to 30 Nm (22 lb.ft).

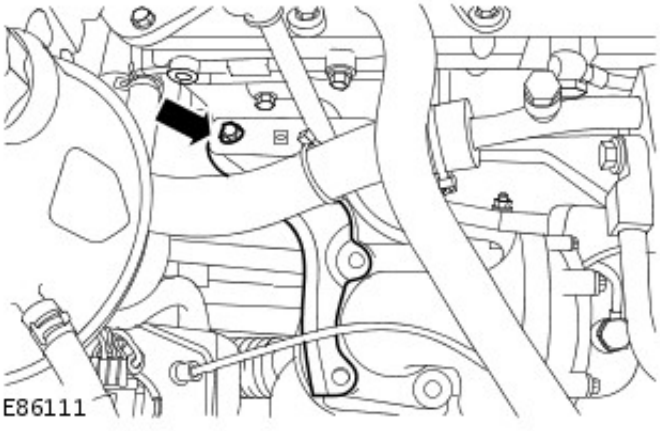


11. Install new nuts.



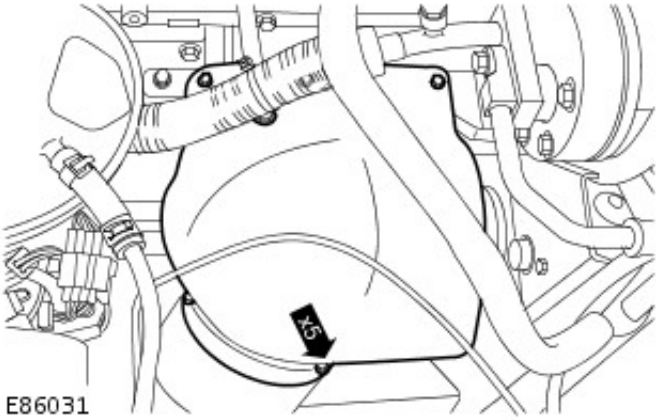
- Tighten to 30 Nm (22 lb.ft).

12. Tighten to 20 Nm (15 lb.ft).

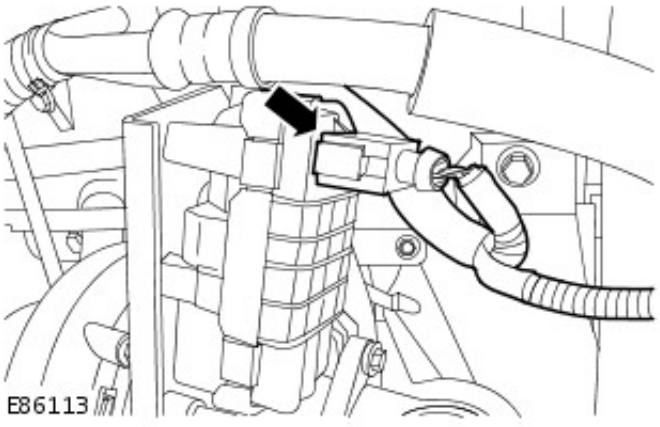


13. Install the turbocharger heat shield.

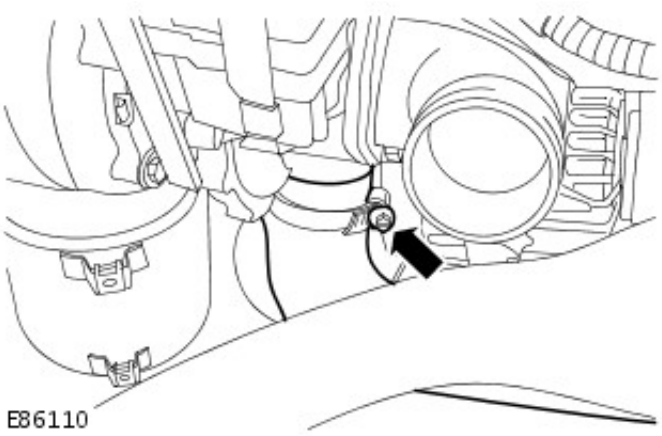
- Tighten to 10 Nm (7 lb.ft).



14. Connect the turbocharger electrical connector.



15. Tighten to 3 Nm (2 lb.ft).



16. Install the air cleaner outlet pipe.
For additional information, refer to: Air Cleaner Outlet Pipe (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

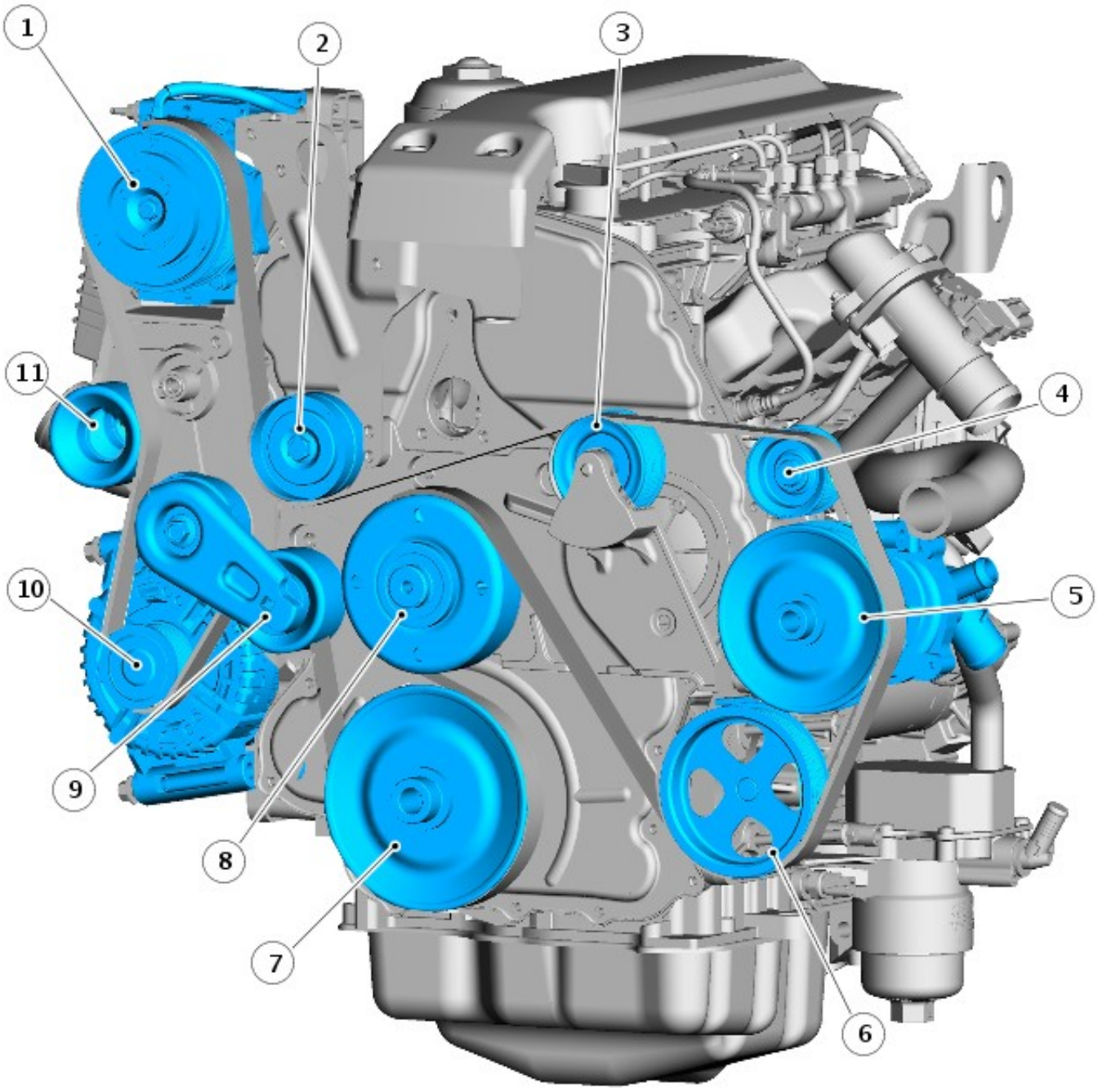
Torque Specifications

Item	Nm	lb-ft
Accessory drive component bracket bolts	48	35
Engine lifting bracket bolts	10	7
Accessory drive belt tensioner bolt	25	18
Accessory drive belt idler pulley bolt	48	35

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive

Description and Operation

COMPONENT LOCATION



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Item	Part Number	Description
1	-	Air conditioning compressor
2	-	Deflection pulley
3	-	Deflection pulley
4	-	Vacuum pump
5	-	Coolant pump
6	-	Power steering pump
7	-	Crankshaft pulley
8	-	Engine cooling fan pulley
9	-	Automatic tensioner
10	-	Generator
11	-	Deflection pulley

OVERVIEW

The engine crankshaft pulley drives the accessory components, which comprise the torsional vibration damper, generator, power steering pump, A/C compressor, vacuum pump and coolant pump, via the accessory drive belt.

The belt, which is maintenance free poly-V type belts, are automatically pre-loaded by the automatic tensioner and are routed over deflection pulleys in order to maintain sufficient adhesion about the drive wheels. This ensures slip-free drive of the accessory components.

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive

Diagnosis and Testing

Overview

For information on the description and operation of the system:
REFER to: Accessory Drive (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

1. **1.** Verify the customer concern.
2. **2.** Visually inspect for obvious mechanical faults.

Visual Inspection Chart

Mechanical
• Drive belt condition (cracking/damage/contamination) • Idler assembly • Generator • Engine cooling fan • Tensioner assembly • Engine coolant pump • Power steering pump • Air conditioning (A/C) compressor • Torsional vibration damper • Accessory drive belt

3. **3.** If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

CAUTION: If the engine is run without the accessory drive belts connected to eliminate driven components, diagnostic trouble codes, (DTCs) may be set which must be cleared before the vehicle is returned to the owner. The engine should not be run for more than 2-3 minutes with the belts disconnected. Failure to follow this instruction may result in damage to the vehicle.

4. **4.** Use the approved diagnostic system or a scan tool to retrieve any DTCs before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart (Accessory Drive Belt)

Symptom	Possible cause	Action
Noise	• Belt condition • Belt tension • Pulleys misaligned • Driven components (including tensioners)	Check the belt condition (see visual inspection). Check the tensioner function. Check the pulley alignment. Check the driven components for excessive resistance to rotation. Rectify as necessary.
Drive belt does not hold tension	• Belt condition • Tensioner fault	Check the belt condition (see visual inspection). Check the tensioner function. Rectify as necessary.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

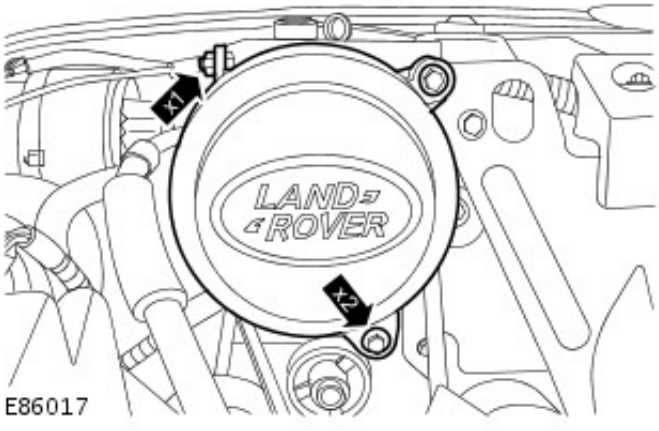
DTC	Description	Possible causes	Action
P062300	Generator lamp control circuit	• Check generator belt is not broken, excessively worn or slipping when engine running • Generator lamp control circuit fault • Generator fault	Check the charging voltage. Install a new accessory drive belt if necessary. REFER to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the charging system circuits. Check the generator lamp control circuit. Refer to the electrical guides. Install a new generator if necessary. REFER to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive Belt

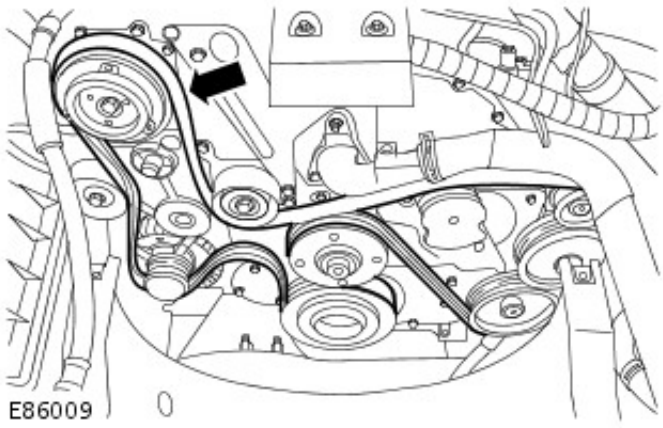
Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the accessory drive belt tensioner.
   For additional information, refer to: Accessory Drive Belt Tensioner (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Remove the air conditioning (A/C) compressor pulley cover.
   - Remove the nut.
   - Remove the 2 bolts.



4. Remove the accessory drive belt.



Installation

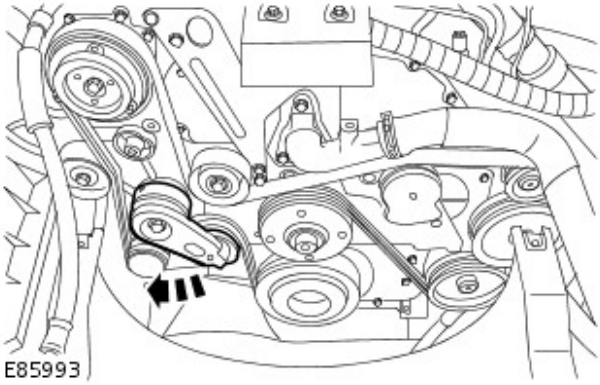
1. To install, reverse the removal procedure.
   - Clean and inspect the drive pulleys for damage.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive Belt Idler Pulley

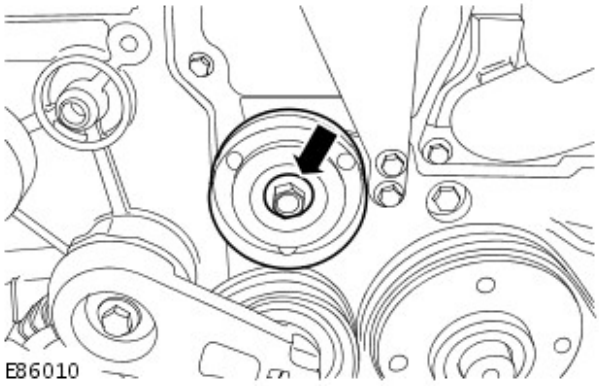
Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the cooling fan.
   For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Release the tension from the accessory drive belt.
   - Rotate the accessory drive belt tensioner clockwise.

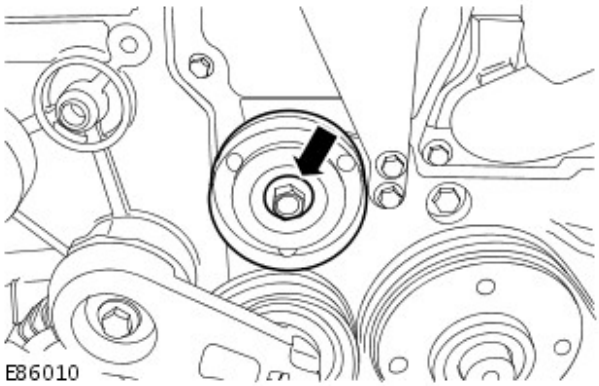


4. Remove the accessory drive belt idler pulley.



Installation

1. To install, reverse the removal procedure.
   - Clean the component mating faces.
   - Tighten the bolt to 48 Nm (35 lb.ft).



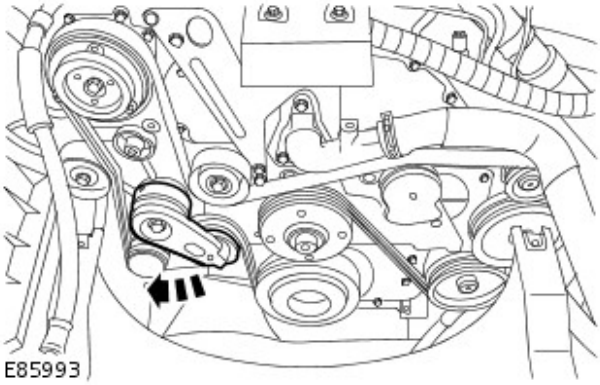
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive Belt Tensioner

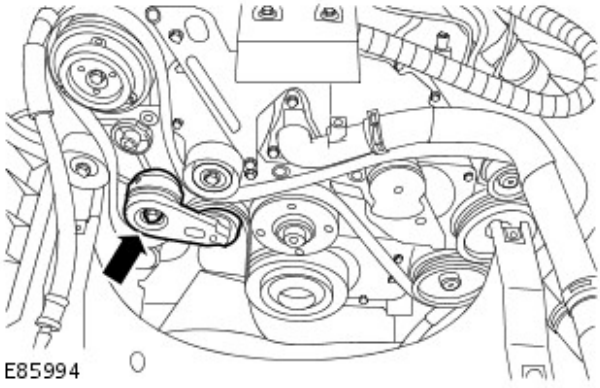
Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the cooling fan.
   For additional information, refer to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Release the tension from the accessory drive belt.
   - Rotate the accessory drive belt tensioner clockwise.

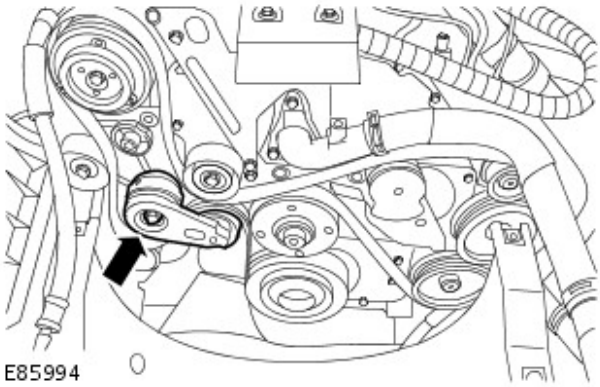


4. Remove the accessory drive belt tensioner.
   - Remove the bolt.



Installation

1. To install, reverse the removal procedure.
   - Clean the component mating faces.
   - Tighten the bolt to 25 Nm (18 lb.ft).



2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accessory Drive Component Bracket

Removal and Installation

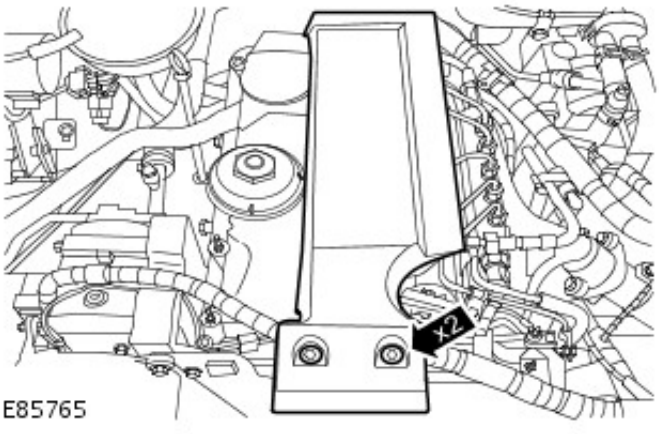
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the accessory drive belt.
For additional information, refer to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

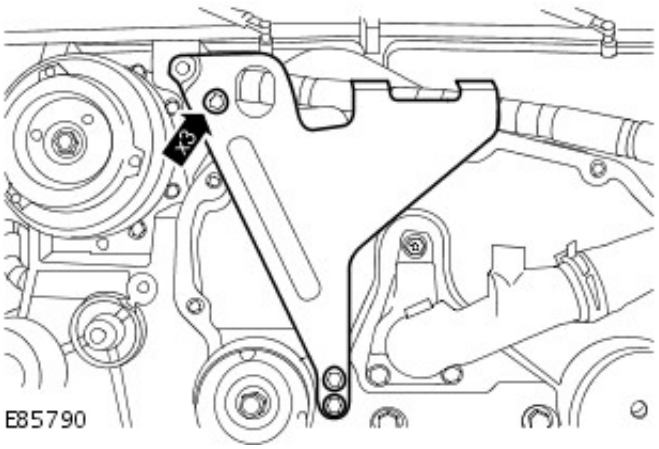
3. Remove the engine cover

1. Remove the 2 bolts



4. Remove the engine lifting bracket.

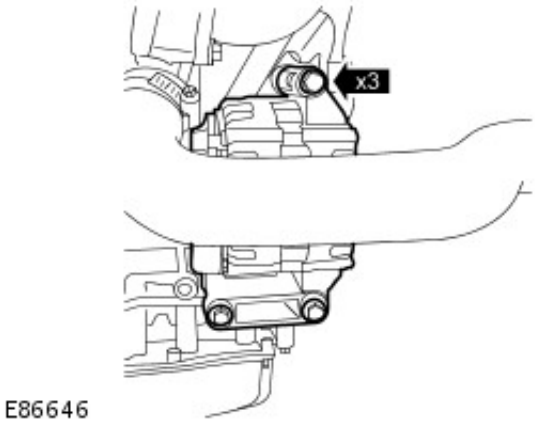
- Remove the 3 bolts.



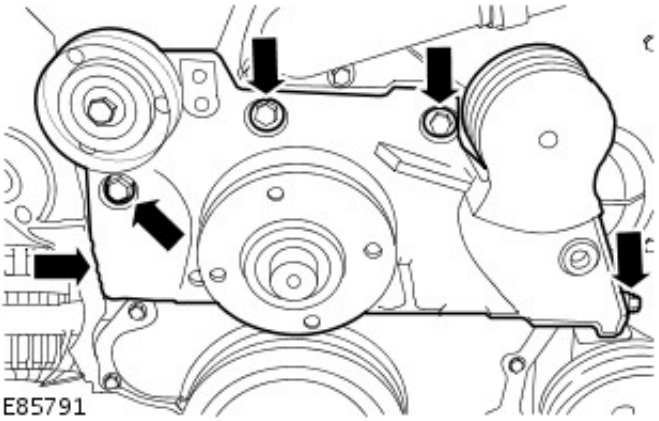
5. NOTE: The generator upper bolt can only be removed when the generator has been released from the accessory drive component bracket.

Release the generator.

- Remove the 3 bolts.

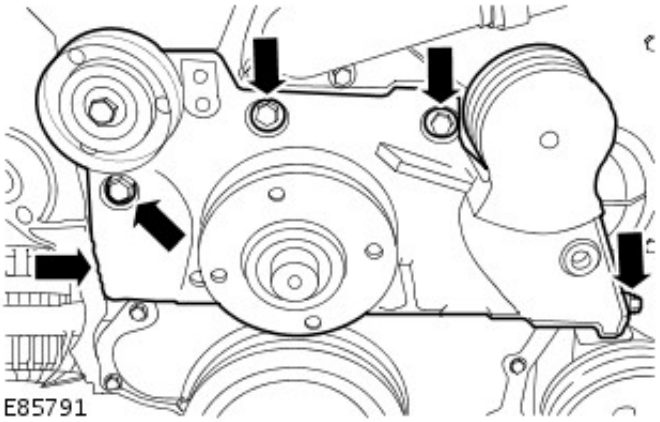


6. Remove the accessory drive component bracket.



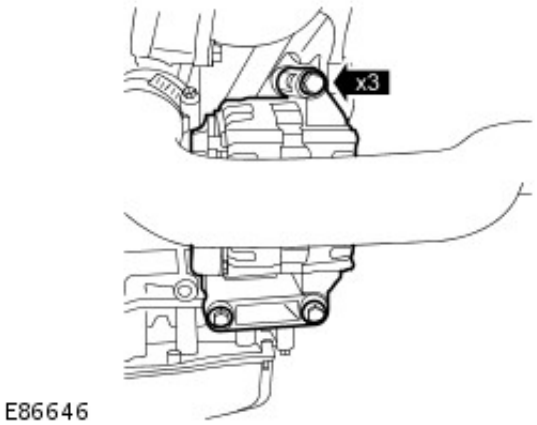
- Remove the 5 bolts.

Installation



1. Install the accessory drive component bracket.

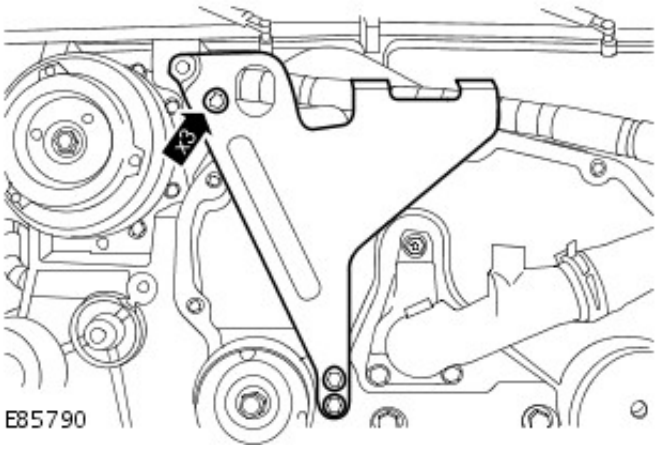
- Tighten the 5 bolts to 48 Nm (35 lb.ft).



2. NOTE: The generator upper bolt must be installed before the generator is installed to the accessory drive component bracket.

Install the generator.

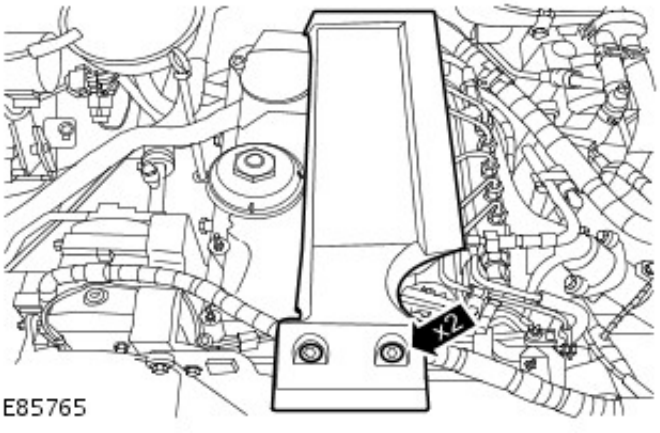
- Tighten the 3 bolts to 48 Nm (35 lb.ft).



3. Install the engine lifting bracket.

- Tighten the 3 bolts to 10 Nm (7 lb.ft).

4. Install the engine cover.



5. Install the accessory drive belt.
   For additional information, refer to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
6. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

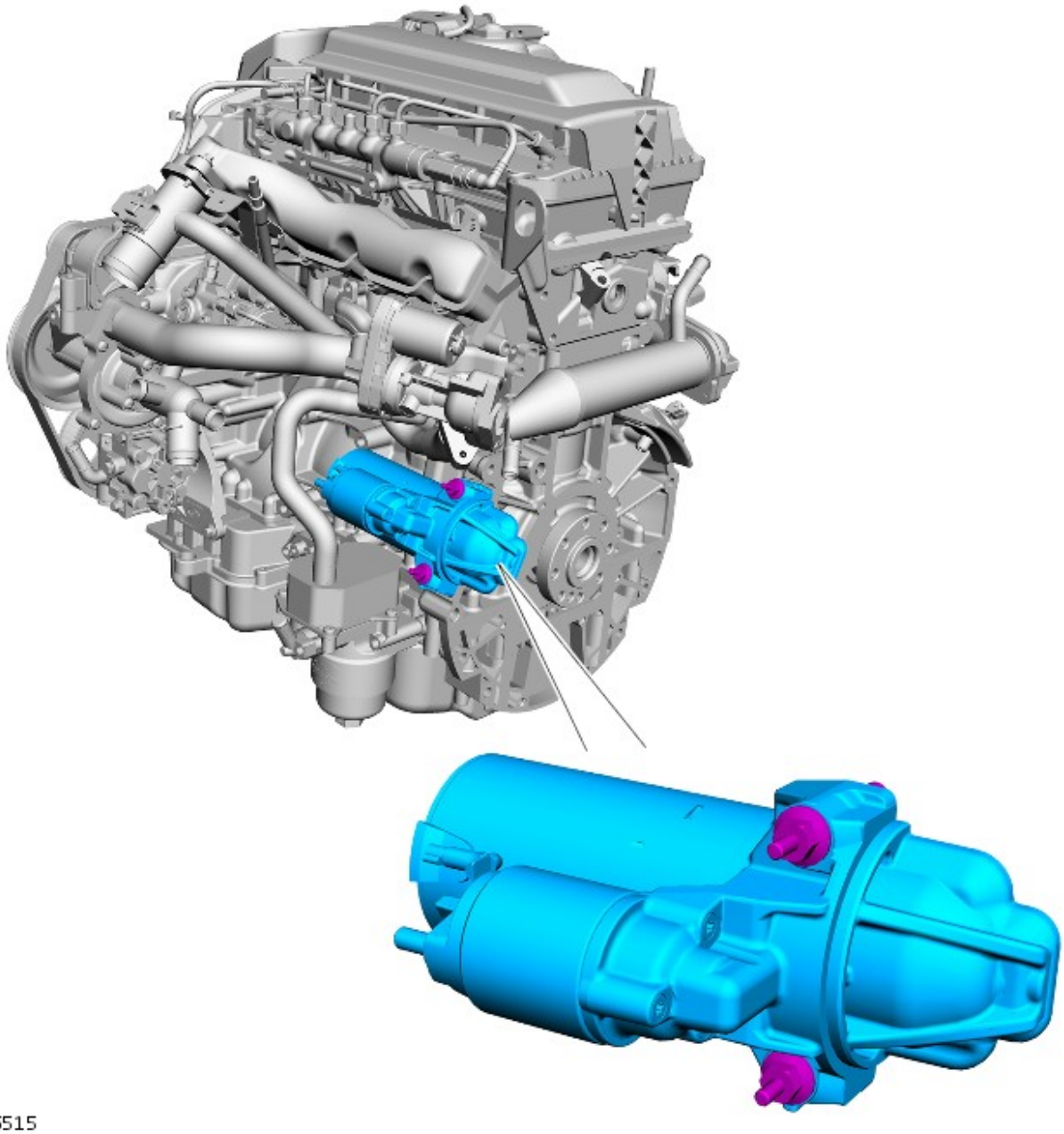
Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Starter motor bolts	35	26
Starter motor battery positive cable nut	12	9
Starter motor solenoid cable nut	8	6
Fuel line support bracket nut	8	6

Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Starting System

Description and Operation

COMPONENT LOCATION



E86515

OVERVIEW

The starter motor is rated as 2.0 kW and is of conventional design with the motor and drive pinion in line with the solenoid mounted above. It is of the pre-engaged type and comprises a series wound motor, an overrunning clutch and an integral solenoid. This starter incorporates a labyrinth in the front end nose casting to help with water management, sealing and drainage. The solenoid is sealed to stop water ingress and to alleviate cranking failures due to moisture.

The starter solenoid is energised by a signal from the Engine Control Module (ECM) when the ignition switch is moved to the crank position. When engine cranking is requested, the ECM checks that a valid key code has been received before granting the crank request. The power for starter operation is supplied on a substantial single cable connected direct from the battery positive terminal. The cable is connected to the solenoid via a copper threaded stud and secured with a nut.

The starter motor is located on the rear LH side of the engine block and protrudes through a recess to drive the flywheel via a ring gear. The motor is secured to the cylinder block by 2 bolts.

Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Starting System

Diagnosis and Testing

Overview

For information on the operation of the system:
REFER to: Starting System (303-06 Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

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

Visual Inspection Chart

Mechanical	Electrical
• Starter motor • Engine (turns freely)	• Battery • Fuses - Fuse link 5, fuse box under seat - Megafuse • Starter relay • Wiring harness(es) • Damaged, loose or corroded connectors • Ignition switch • Generator • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible causes	Action
The engine does not crank (starter motor does **not** turn)	• Battery • Starter relay - Output circuit: high resistance - Output circuit: short circuit to power • Invalid key code received by immobilizer • Harness/connectors • Starter motor • Ignition switch • Generator • Engine seized	Check the battery condition and state of charge. Check for DTCs indicating an immobilizer fault. Check the starter motor relay, ignition switch and generator circuits. Refer to the electrical guides. Check that the engine turns freely.
The engine does not crank (starter motor **does** turn)	• Starter motor fitment • Starter motor • Flywheel/drive plate ring gear	Check the starter motor fitment (fasteners tight, starter motor square to engine, etc.). Check the flywheel/drive plate ring gear teeth for damage, foreign objects, etc.
Engine cranks too slowly	• Battery • Harness/connectors • Starter motor • Oil grade	Check the battery condition and state of charge. Check the starter motor circuits. Refer to the electrical guides. Check the engine oil grade and condition.
Engine cranks too fast	• Low engine compression	Check the engine condition and compressions.
Excessive starter motor noise	• Starter motor • Flywheel/drive plate ring gear Starter motor	Check the starter motor fitment (fasteners tight, motor square to engine, etc.). Check the starter motor casing condition. Check the

	• Starter motor fitment/casing	flywheel/drive plate ring gear teeth for damage, foreign objects, etc.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible causes	Action
P061512	Starter relay circuit - circuit short to battery	• Starter relay circuit: short circuit to power	Check the starter relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P061514	Starter relay circuit - circuit short to ground or open	• Starter relay circuit: short circuit to ground • Starter relay circuit: open circuit	
P160231	Immobilizer/engine control module (ECM) communication error – no signal	• Alarm (immobilizer) - instrument cluster circuit: short circuit to ground • Alarm (immobilizer) - instrument cluster circuit: short circuit to power • Alarm (immobilizer) - instrument cluster circuit: open circuit • Engine control module (ECM) fault • Instrument cluster fault	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the alarm (immobilizer) circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.

Starting System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Starter Motor

Removal and Installation

Removal

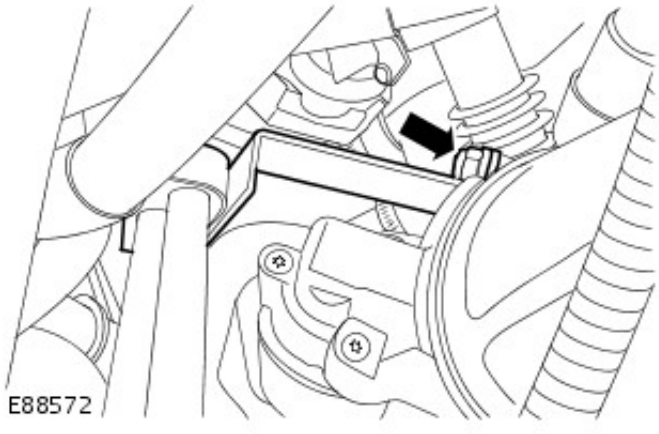
1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

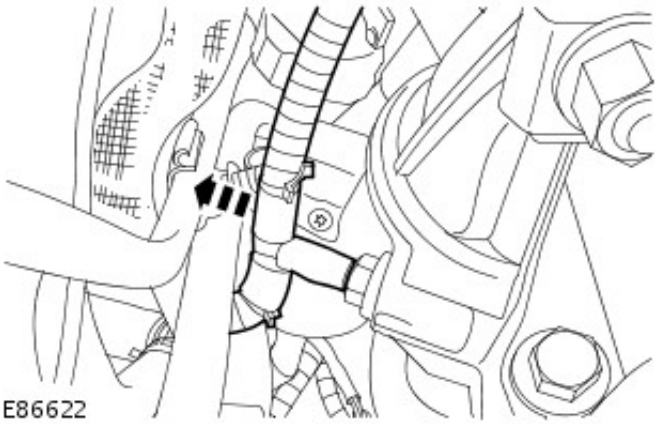
Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

3. Remove the fuel line support bracket.

- Remove the nut.

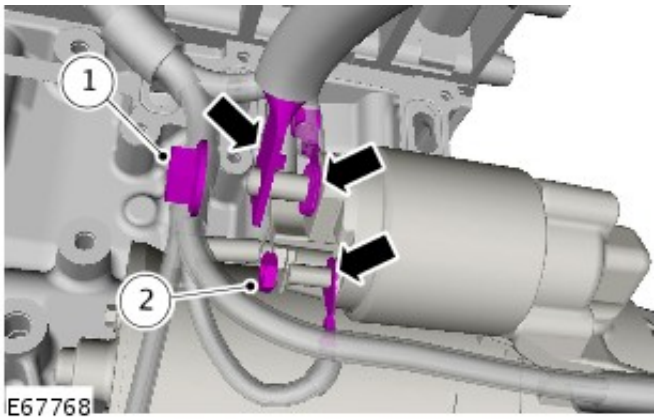


4. Release the starter motor wiring harness clip.

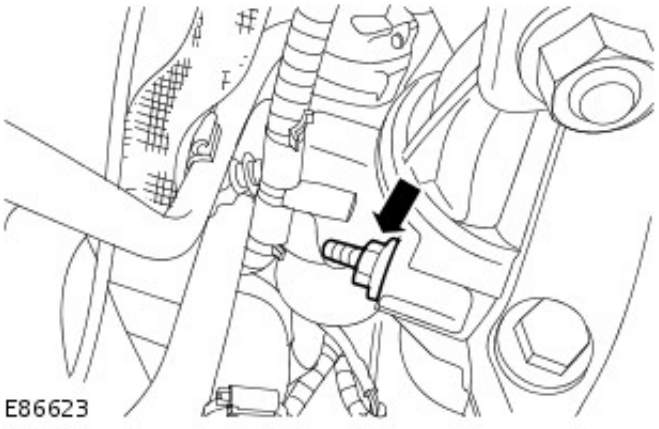


5. Release the 2 battery positive cables and the switch lead from the starter motor solenoid.

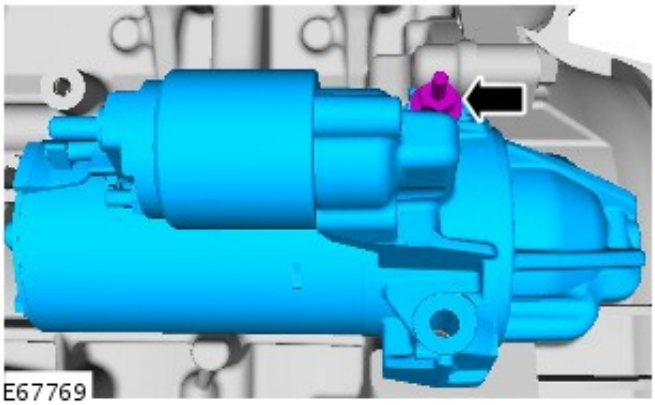
1. Remove the battery positive cable nut.
2. Release the starter motor switch lead nut.



6. Remove the starter motor lower bolt.



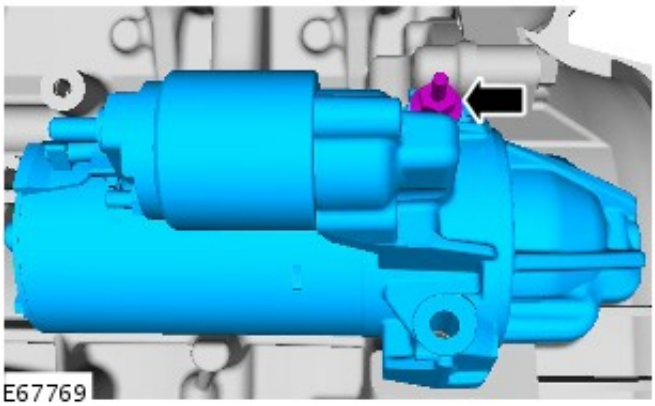
7. Remove the starter motor.



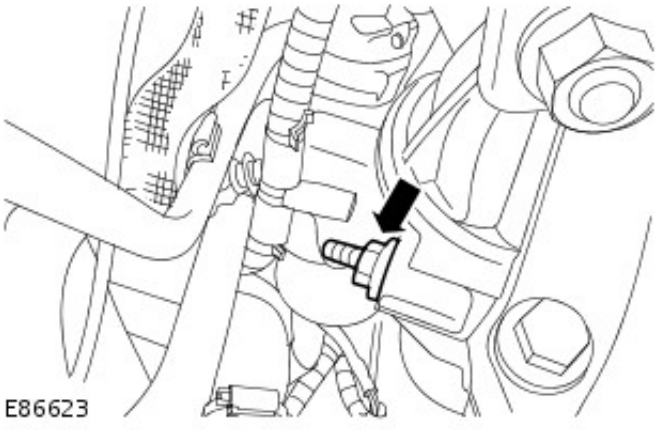
Installation

1. Install the starter motor.

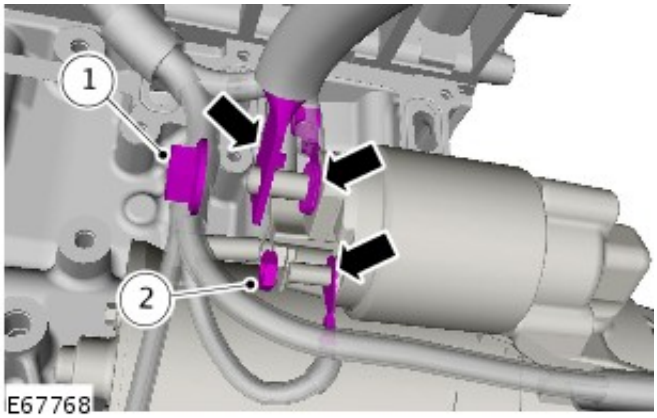
- Tighten to 35 Nm (26 lb.ft).



2. Tighten to 35 Nm (26 lb.ft).



3. Secure the 2 battery positive cables and the switch lead to



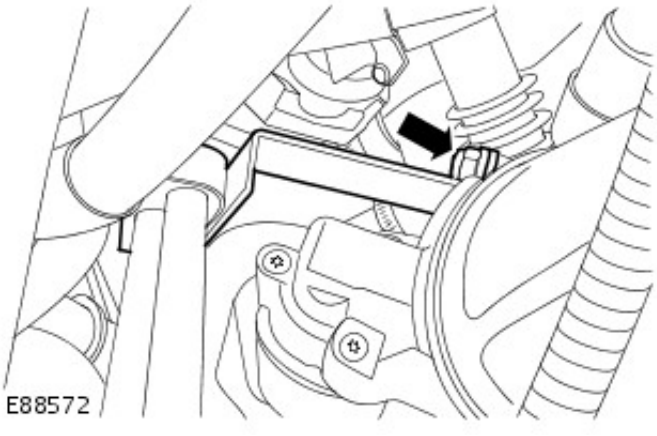
the starter motor solenoid.

1. Tighten to 12 Nm (9 lb.ft).
2. Tighten to 8 Nm (6 lb.ft).

4. Secure the starter motor wiring harness clip.

5. Install the fuel line support bracket.

- Tighten to 8 Nm (6 lb.ft).



6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

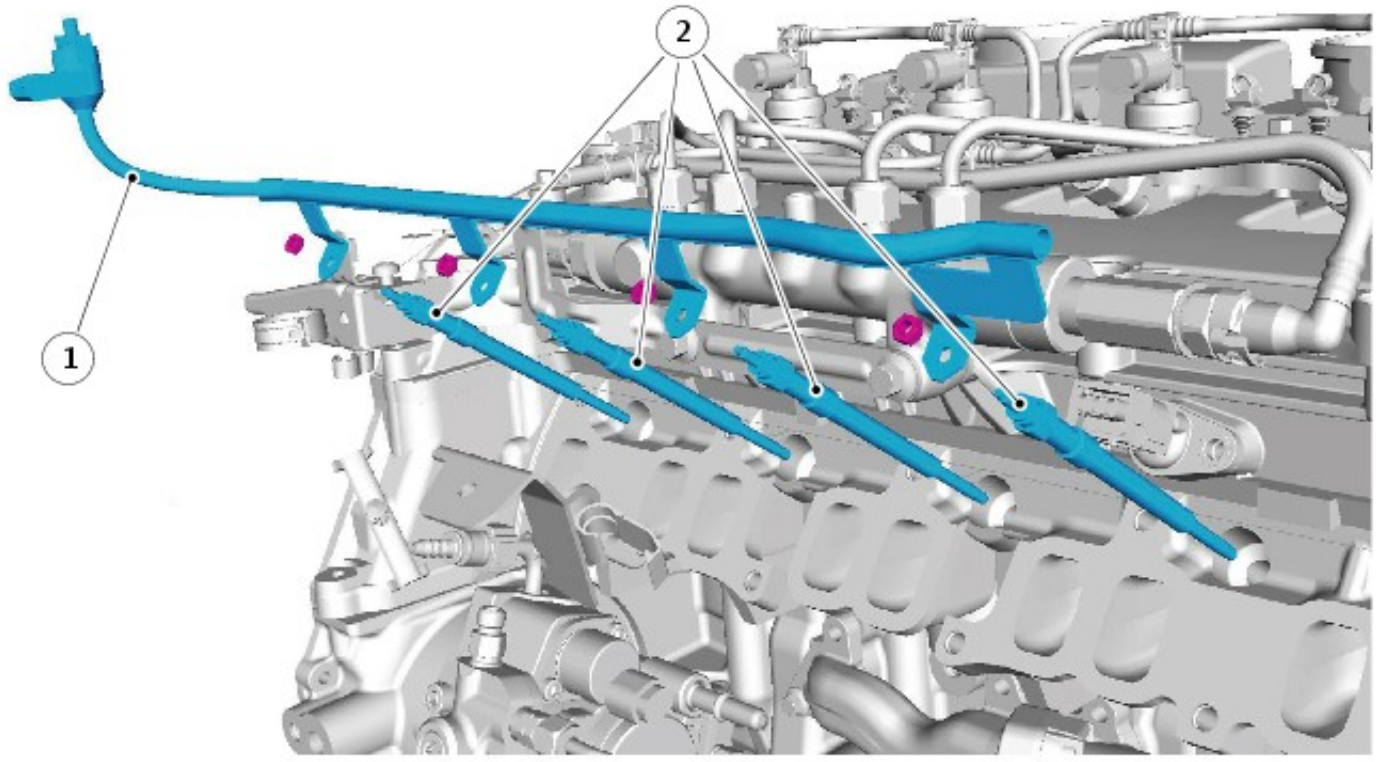
Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Item	Nm	lb-ft
Glow plug wiring harness nuts	2	1
Glow plugs	13	10

Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Glow Plug System

Description and Operation

COMPONENT LOCATION



E85330

Item	Part Number	Description
1	-	Glow plug wire
2	-	Glow plug(s)

OVERVIEW

The glow plugs are located in the side of the cylinder head and aid engine starting and efficiency. The glow plugs and the glow plug indicator lamp are controlled by the Engine Control Module (ECM).

The glow plugs preheat the combustion chambers, which aids cold starting. During the preheat stage, the ECM receives an engine temperature signal from the cylinder head temperature (CHT) sensor and this determines the preheat time. The lower the temperature, the longer the preheat time. There is a maximum preheat time of 8 seconds at -20°C or lower. At temperatures above 80°C there is no preheat phase.

Once the engine has started, the glow plugs enter an after-glow phase. The after-glow phase helps to improve idling and reduce hydrocarbon emissions through more efficient combustion just after starting. The after-glow phase only operates at engine speeds below 2500 RPM, above that, the after-glow phase is interrupted to increase the durability of the glow plugs. There is a maximum after-glow time of 30 seconds at -20°C or lower. At temperatures above 50°C there is no after-glow phase.

Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Glow Plug System

Diagnosis and Testing

Overview

For information on description and operation:
REFER to: Glow Plug System (303-07 Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

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

Visual Inspection Chart

Electrical
• Glow plug lamp • Fuses - Link 1, fuse box under seat • Glow plug relay • Engine management relay • Wiring harness/connectors • Glow plugs • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible cause	Action
Poor starting (extreme weather conditions)	• Glow plugs inoperative/inefficient • Fuel temperature too low - The fuel system recycles fuel until operating temperature is reached to reduce this possibility	Check the glow plug harnesses at the glow plugs and at the connections to the main harness. Refer to the electrical guides. Check for DTCs indicating a glow plug fault. Rectify as necessary. Clear the DTCs and check for normal operation.
High cold-engine emissions	• After-glow phase inoperative	Check the glow plug harnesses at the glow plugs and at the connections to the main harness. Refer to the electrical guides. Check for DTCs indicating a glow plug fault. Rectify as necessary. Clear the DTCs and check for normal operation. After-glow is designed to function at engine temperatures below 50°C (122°F), below 2,500 rpm and for a maximum of 30 seconds after engine starting.
High cold-engine noise, vibration or harshness	• After-glow phase inoperative	Check the glow plug harnesses at the glow plugs and at the connections to the main harness. Refer to the electrical guides. Check for DTCs indicating a glow plug fault. Rectify as necessary. Clear the DTCs and check for normal operation. After-glow is designed to function at engine temperatures below 50°C (122°F), below 2,500 rpm and for a maximum of 30 seconds after engine starting.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

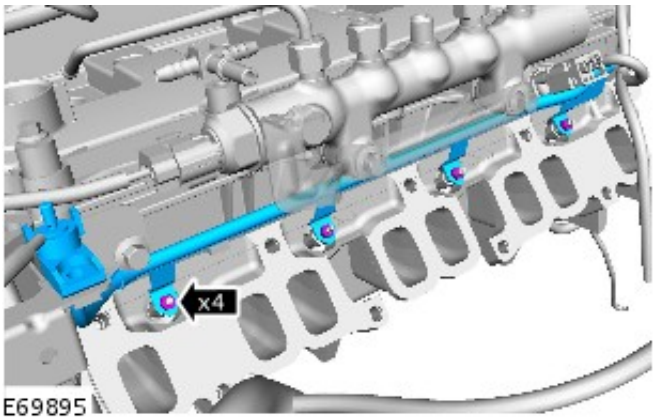
DTC	Description	Possible cause	Action
P037D29	Glow plug relay sensor circuit - signal invalid	• Glow plug short circuit to ground • Relay circuit to relay • Relay circuit from relay • Glow plug relay fault	Check the relay and circuits. Refer to the electrical guides. Activate the relay and check for an audible "click". Rectify as necessary. Clear the DTCs and test for normal operation.
P038011	Glow plug/heater circuit A - circuit short to ground	• Glow plug relay control circuit: short circuit to ground • Glow plug relay fault	Check the relay and circuits. Refer to the electrical guides. Activate the relay and check for an audible "click". Rectify as necessary. Clear the DTCs and test for normal operation.
P038015	Glow plug/heater circuit A - circuit short to battery or open	• Glow plug relay control circuit: short circuit to power • Glow plug relay control circuit: open circuit • Glow plug relay fault	

Glow Plug System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Glow Plug

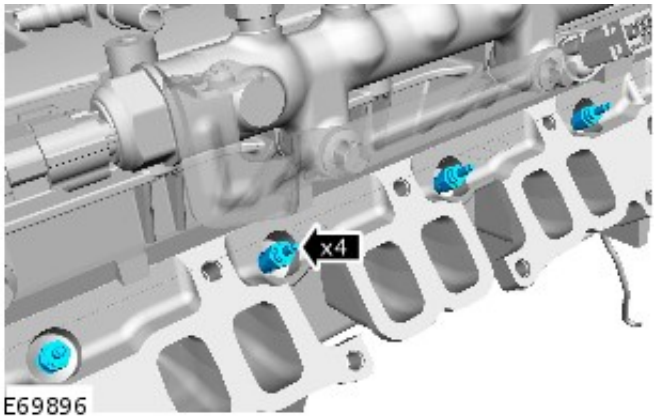
Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the intake manifold.
   For additional information, refer to: Intake Manifold (303-01 Engine - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
3. Release the glow plug wiring harness.
   - Remove the 4 nuts.

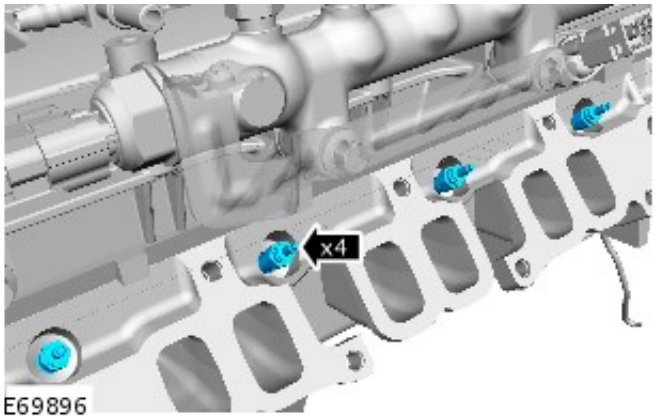


4. Remove the glow plugs.

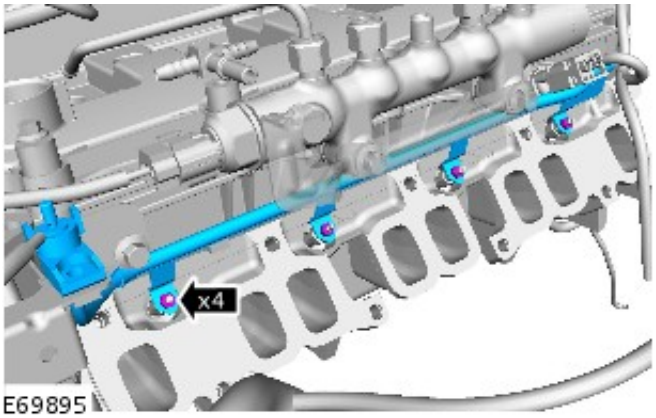


Installation

1. To install, reverse the removal procedure.
   - Tighten to 13 Nm (10 lb.ft).



2. Tighten to 2 Nm (1 lb.ft).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E69895

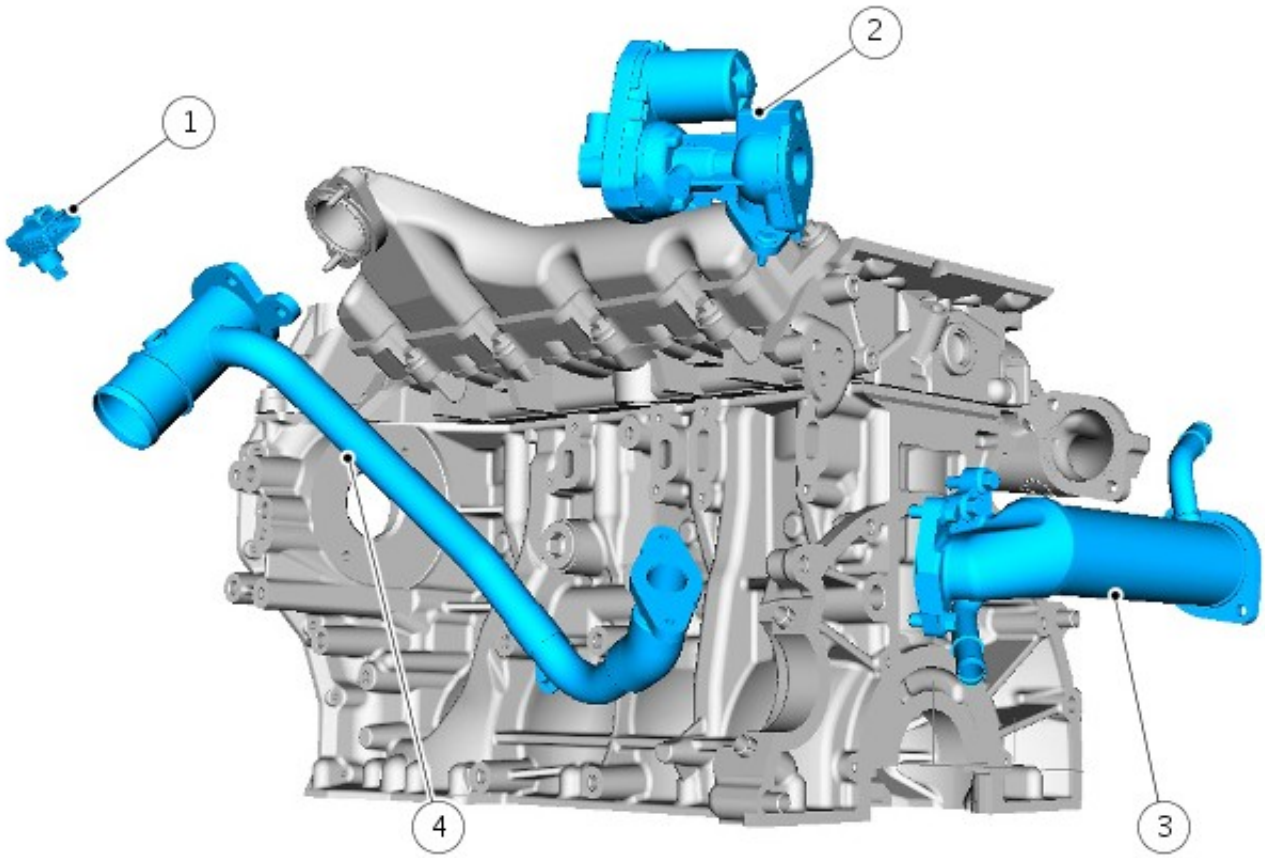
Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Exhaust gas recirculation (EGR) valve to EGR valve outlet tube bolts	10	7
EGR valve to EGR cooler bolts	23	17
Exhaust manifold to EGR cooler bolts	23	17
EGR valve outlet tube to cylinder block bolt	23	17

Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Emission Control

Description and Operation

exhaust gas recirculation (EGR) COMPONENT LOCATION



E63622

Item	Part Number	Description
1	-	manifold absolute pressure (MAP) sensor (shown for location purposes only)
2	-	EGR valve
3	-	EGR cooler
4	-	Gas transfer and mixer pipes

OVERVIEW

The EGR system comprises:

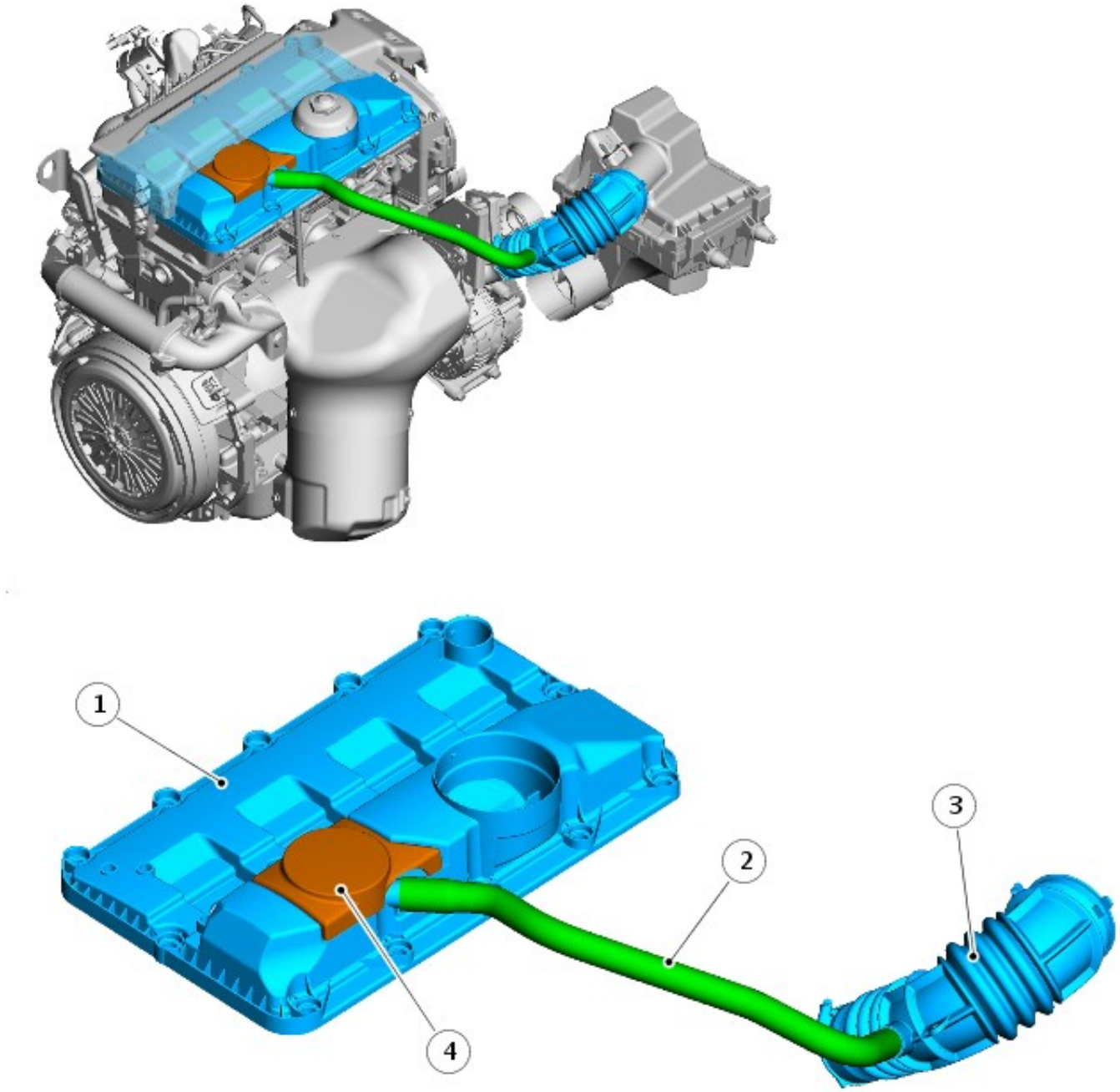
- EGR modulator
- EGR cooler
- Gas transfer pipe and mixer

The EGR cooler receives exhaust gas directly from the exhaust manifold, where it is cooled by a water matrix which is integrated into the overall engine cooling system.. Attached to the Cool side of the cooler is the EGR valve. This valve is motor driven – controlled by the engine control module (ECM) to provide varying amounts of EGR recirculation depending on the engine operation. At engine switch off the valve opens and closes several times to clear any deposits which may have accumulated during running.

The EGR pipe transports the cooled gas to the mixer where it is blended into to the incoming air stream.

The ECM monitors the EGR system function and stores fault codes in the event of failure. The EGR valve can also be activated for testing using the Land Rover recommended diagnostic tool.

CRANKCASE VENTILATION COMPONENT LOCATION



E86519

Item	Part Number	Description
1	-	Cylinder head cover
2	-	Gas transfer pipe
3	-	Air intake tube
4	-	Oil separator

OVERVIEW

The crankcase ventilation system on the engine manages the positive pressure built up during running. In order to prevent excessive oil loss/consumption the separator ensures that all gasses emitted from the crankcase during engine running are separated from any oil particles.

Crankcase gas enters the oil separator unit located in the engine cam cover due to the pressure differential between the crank case and the air induction duct. The oil separator removes oil from the crankcase gasses. The crank case pressure is released into the air induction system via the Crank Case Vent Tube. The separated oil drains from the separator to the oil pan via the engines internal oil galleries.

Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Emission Control

Diagnosis and Testing

Overview

For information on description and operation:
REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

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

Visual Inspection Chart

Mechanical	Electrical
• Engine breather hoses • Oil separator • Exhaust gas recirculation (EGR) pipes (check for cracks) • EGR valve • EGR cooler(s)	• Fuse(s) • Wiring harness • Loose or corroded electrical connector(s) • EGR valve • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom (specific)	Possible cause	Action
Difficult to start Poor/Erratic idle Lack of power when accelerating	• Exhaust gas recirculation (EGR) valve stuck open	Check the EGR valve and circuits. Refer to the electrical guides. Check the mechanical condition of the EGR valve. Rectify as necessary.
Engine stops/stalls	• Exhaust gas recirculation (EGR) valve stuck open • Breather system disconnected/restricted/blocked	Check the EGR valve and circuits. Refer to the electrical guides. Check the mechanical condition of the EGR valve. Check the engine breather system. Check the oil separator. REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation). Check for DTCs indicating an EGR valve, throttle or sensor fault. Rectify as necessary.
Excessive fuel consumption Excessive black smoke Excessive emissions	• Exhaust gas recirculation (EGR) valve stuck open • EGR not operating • Breather system restricted/blocked	
Excessive blow-by	• Breather system restricted/blocked	Check the engine breather hoses. Check the oil separator. REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation). Rectify as necessary.
Engine oil leaks	• Breather system restricted/blocked	Check the engine breather hoses. Check the oil separator. REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation). Rectify as necessary.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible cause	Action
P006A00	Manifold absolute pressure (MAP) sensor - mass or volume air flow correlation	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • Restricted air intake path • Exhaust gas recirculation (EGR) valve stuck open • Turbocharger fault • MAP sensor fault • Mass air flow (MAF) sensor fault	Check the intake air path for restrictions. Rectify as necessary. Check for DTCs indicating an EGR, turbocharger, MAPT or MAF sensor fault. Rectify as necessary. Clear the DTCs and check for normal operation.
P010029	Mass or volume air flow A circuit - signal invalid	• Restricted air intake path • Check for leak between mass air flow (MAF) sensor and turbocharger • MAF sensor fault • Turbocharger fault • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks, restrictions, etc. Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation.
P04031A	Exhaust gas recirculation (EGR) control circuit - circuit resistance below threshold	• EGR control valve actuator circuit: short circuit to ground • EGR control valve actuator circuit: short circuit to power • EGR control valve actuator circuit: open circuit • EGR control valve fault	Check the EGR control valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P04031B	Exhaust gas recirculation (EGR) control circuit - circuit resistance above threshold	• EGR control valve actuator circuit: short circuit to ground • EGR control valve actuator circuit: short circuit to power • EGR control valve actuator circuit: open circuit • EGR control valve fault	
P040311	Exhaust gas recirculation (EGR) control circuit - circuit short to ground	• EGR control valve actuator circuit: short circuit to ground • EGR control valve fault	
P040312	Exhaust gas recirculation (EGR) control circuit - circuit short to battery	• EGR control valve actuator circuit: short	

		circuit to power • EGR control valve fault	
P040472	Exhaust gas recirculation (EGR) control circuit range/performance - actuator stuck open	• EGR control valve actuator circuit fault • EGR control valve fault	Check the EGR control valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P040473	Exhaust gas recirculation (EGR) control circuit range/performance - actuator stuck closed	• EGR control valve actuator circuit fault • EGR control valve fault	
P14022F	Exhaust gas recirculation (EGR) control valve metering orifice restricted - signal erratic	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve control circuit: short circuit to power • EGR valve fault	Check the EGR valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P140216	Exhaust gas recirculation (EGR) control valve - circuit voltage below threshold	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve fault	
P140217	Exhaust gas recirculation (EGR) control valve - circuit voltage above threshold	• EGR valve control circuit: short circuit to power • EGR valve fault	
P140977	Exhaust gas recirculation (EGR) control valve vacuum regulator solenoid circuit - commanded position not reachable	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve control circuit: short circuit to power • EGR valve fault	Check the EGR valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Exhaust Gas Recirculation (EGR) Cooler

Removal and Installation

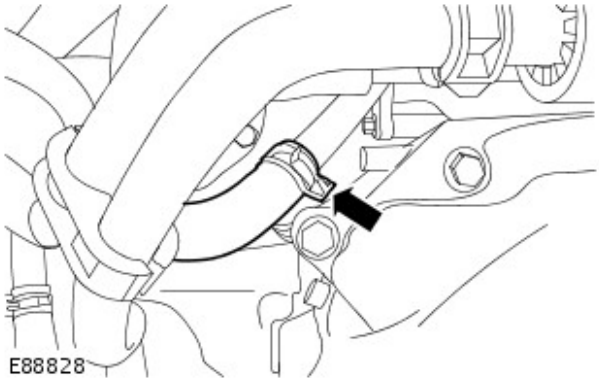
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

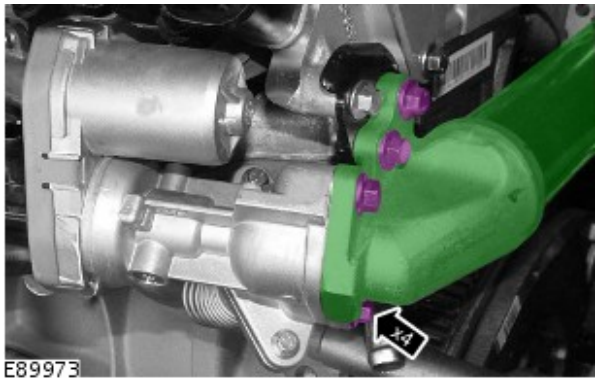
Raise and support the vehicle.

3. NOTE: Position a container to collect the fluid spillage.


E88828

Disconnect the exhaust gas recirculation (EGR) cooler LH coolant hose.

- Clamp the hose to minimize coolant loss.
- Release the clip.



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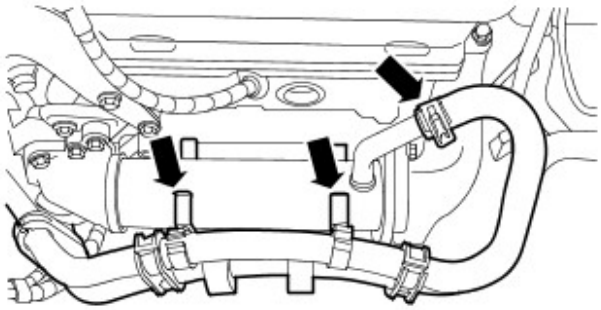
4. Release the EGR cooler from the EGR valve and from the EGR cooler bracket.

- Remove the 4 bolts.
- Remove and discard the gasket.

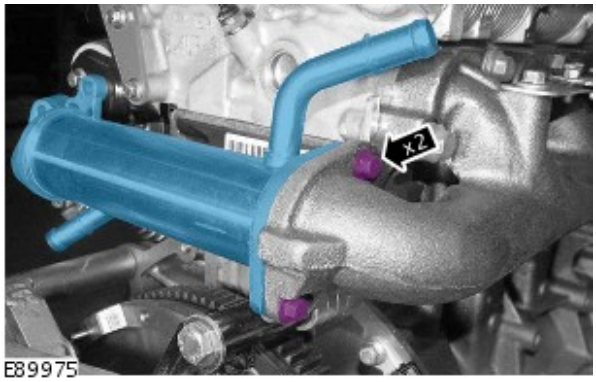

E88840

5. Disconnect the EGR cooler RH coolant hose.

- Clamp the hose to minimize coolant loss.
- Release the clip.
- Release the coolant hoses from the EGR cooler.

6. Reposition the coolant expansion tank.

- Remove the bolt.



7. NOTE: Engine shown removed for clarity.

Remove the EGR cooler.

- Remove the 2 bolts.
- Remove and discard the gasket.

Installation

1. NOTE: Clean the component mating faces.

Install the EGR cooler.

- Install a new gasket.
- Tighten the bolts to 23 Nm (17 lb.ft).

2. Secure the coolant expansion tank.

- Tighten the bolt to 10 Nm (7 lb.ft).

3. Connect the EGR cooler RH coolant hose.

- Secure with the clip.
- Secure the coolant hoses to EGR cooler.
- Remove the hose clamp.

4. Secure the EGR cooler to the EGR valve and the EGR cooler bracket.

- Install a new gasket.
- Tighten the bolts to 23 Nm (17 lb.ft).

5. Connect the EGR cooler LH coolant hose.

- Secure with the clip.
- Remove the hose clamp.
- Remove the container.

6. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

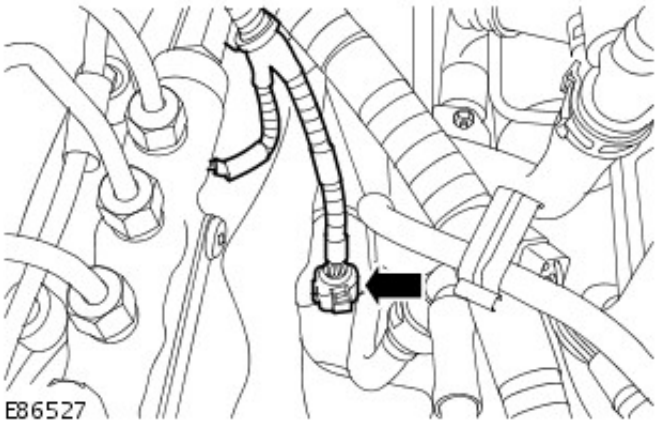
7. Check and top up the coolant.

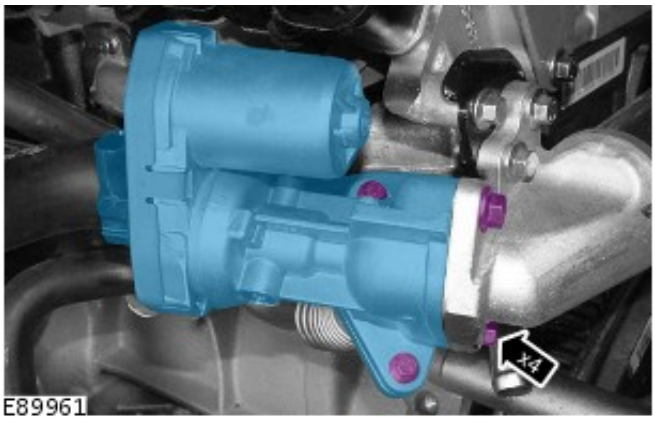
Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Exhaust Gas Recirculation (EGR) Valve

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Disconnect the exhaust gas recirculation (EGR) valve electrical connector.





3. NOTE: Engine shown removed for clarity.

   Remove the EGR valve.

   - Remove the 4 bolts.
   - Remove and discard the 2 gaskets.

Installation

1. Install the EGR valve.
   - Clean the component mating faces.
   - Install new gaskets.
   - Tighten the M6 bolts to 10 Nm (7lb.ft).
   - Tighten the M8 bolts to 23 Nm (17lb.ft).
2. Connect the EGR valve electrical connector.
3. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

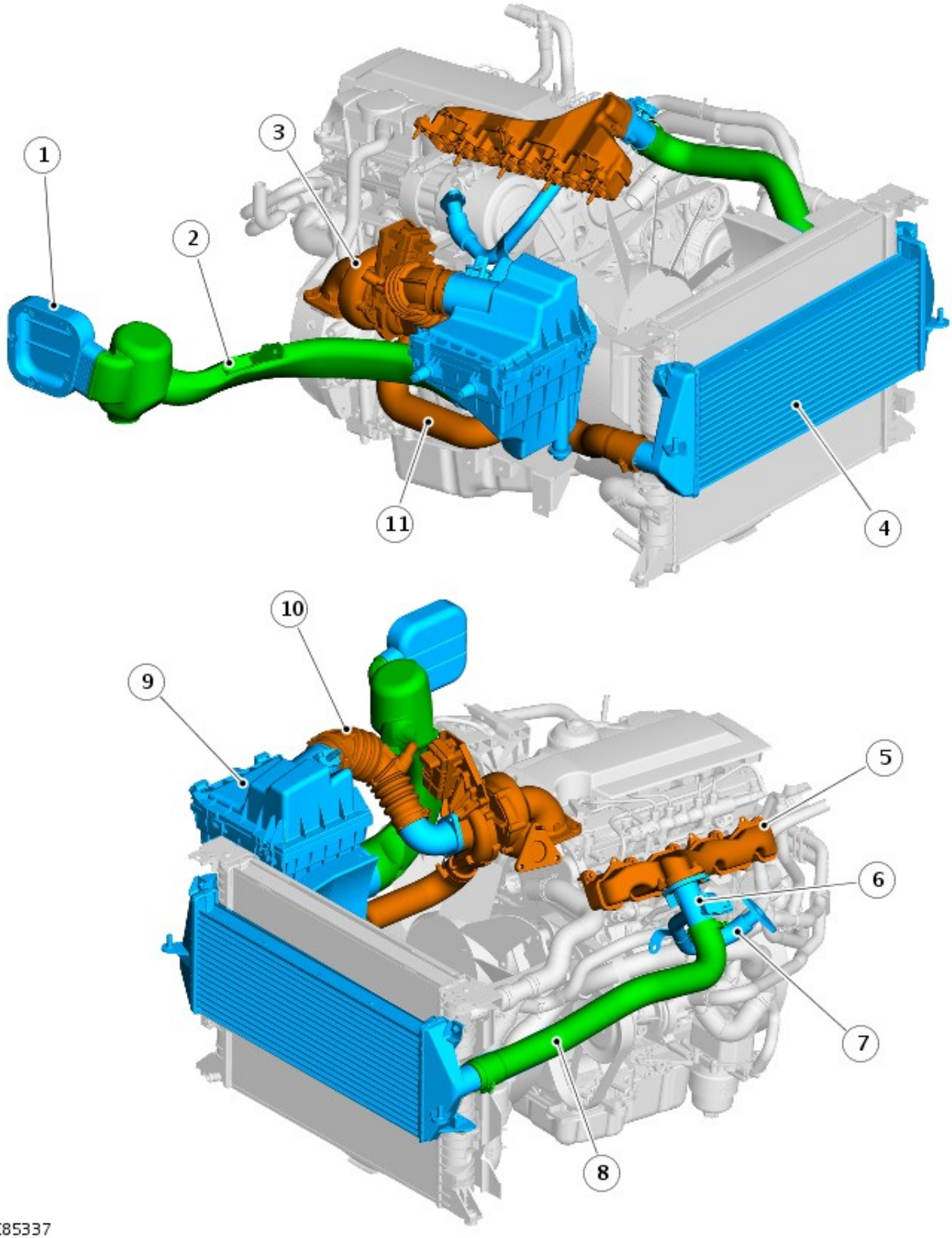
Torque Specifications

Description	Nm	lb-ft
Air cleaner bolts	13	10
A/C compressor low-pressure and high-pressure refrigerant lines bolt	30	22
Charge air cooler to radiator bolts	20	15
Charge air cooler inlet and outlet hose clips	3	2
Charge air cooler bracket bolts	9	7
Air cleaner outlet pipe clips	3	2

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Intake Air Distribution and Filtering

Description and Operation

COMPONENT LOCATION



Item	Part Number	Description

1	-	Air intake
2	-	Dirty air duct
3	-	Turbocharger
4	-	Charge air cooler
5	-	Air intake manifold
6	-	Mass airflow sensor housing and exhaust gas recirculation (EGR) connection
7	-	EGR connection tube
8	-	Charge air cooler to intake manifold tube
9	-	Air cleaner box
10	-	Air cleaner box to turbo tube
11	-	Turbo charger to charge air cooler tube

OVERVIEW

Air is drawn in from the vehicle exterior via the right-hand (RH) wing mounted intake duct, along the inside of the wing to the air cleaner box intake. Once the air has passed through the air cleaner it is drawn along a duct to the turbocharger. From the turbo charger the air is forced through the charge air cooler up to the intake manifold.

AIR CLEANER BOX

The air cleaner box is located on the inside of the right hand fender. The air cleaner box is attached to the vehicle by four rubber mounts, 2 on the side to the inside of the inner fender and two on the base of the box. The box contains a replaceable paper filter element.

CHARGE AIR COOLER

The charge air cooler is located in front of the radiator and is secured to the radiator by 2 bolts at the top and 2 location points at the bottom. Air is forced through the charge air cooler by the turbocharger. Cooling the air makes it more dense improving combustion.

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Intake Air Distribution and Filtering

Diagnosis and Testing

Overview

For information on description and operation:
REFER to: Intake Air Distribution and Filtering (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

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

Visual Inspection Chart

Mechanical	Electrical
• Hoses and ducts: condition and fitment • Air cleaner element condition and fitment • Restricted air intake • Vacuum hoses condition and fitment • Pipework to/from turbocharger: condition and fitment • Turbocharger: condition and fitment • Charge air cooler	• Fuse(s) • Wiring harness(es) • Loose or corroded electrical connector(s) • Mass air flow (MAF) sensor • Manifold absolute pressure/temperature (MAPT) sensors • Intake air temperature (IAT) sensor - IAT sensor 1 is part of the MAF sensor

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible causes	Action
Vehicle does not start/hard starting	• Restricted/blocked air intake • Restricted/blocked air cleaner element	Check the intake air system for blockages or restriction. Rectify as necessary.
Poor performance	• Intake air system fault • Turbocharger fault(s) • Exhaust gas recirculation (EGR) valve fault • Low fuel pressure • Restricted exhaust system	Check the intake air system for blockages or restriction. Rectify as necessary. Check for DTCs indicating a turbocharger, EGR valve or fuel pressure fault. Rectify as necessary. Check the exhaust system for evidence of damage or restriction. Rectify as necessary.
Excessive intake noise	• Intake air leak after the turbocharger • Intake pipe disconnected/damaged after the air cleaner • Air cleaner assembly incorrectly assembled/damaged	Check the intake air system for loose or disconnected hoses or ducts. Check the hoses and ducts for damage, splits, etc. Rectify as necessary.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

• NOTE: For a full list of engine control module (ECM) DTCs:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC	Description	Possible causes	Action
P00952F	Intake air temperature (IAT) sensor 2 circuit - signal erratic	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2 circuit: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009511	Intake air temperature (IAT) sensor 2 circuit - circuit short to ground	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009515	Intake air temperature (IAT) sensor 2 circuit - circuit short to battery or open	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010029	Mass or volume air flow A circuit - signal invalid	• Restricted air intake path • Check for leak between mass air flow (MAF) sensor and turbocharger • MAF sensor fault • Turbocharger fault • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks, restrictions, etc. Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation.
P010036	Mass or volume air flow A circuit - signal frequency too low	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010037	Mass or volume air flow A circuit - signal frequency too high	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

P010064	Mass or volume air flow A circuit - signal plausibility failure	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P01102F	Intake air temperature (IAT) sensor 1 circuit - signal erratic	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to power • IAT sensor 1 circuit: short circuit to ground • IAT sensor 1 circuit: open circuit • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011011	Intake air temperature (IAT) sensor 1 circuit - circuit short to ground	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to ground • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011015	Intake air temperature (IAT) sensor 1 circuit - circuit short to battery or open	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to power • IAT sensor 1 circuit: open circuit • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P110200	Mass air flow (MAF) sensor in range but lower than expected	• Intake air path fault • MAF sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the intake air system for leaks, restrictions, etc. Check the MAF sensor and circuits. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P110300	Mass air flow (MAF) sensor in range but higher than expected	• Intake air path fault • MAF sensor circuit: open circuit • MAF sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor fault	Check the intake air system for leaks, restrictions, etc. Check the MAF sensor and circuits. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Air Cleaner

Removal and Installation

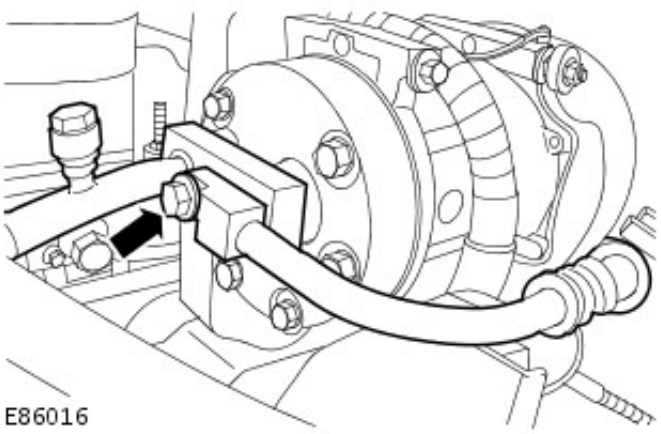
Removal

All vehicles

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

Vehicles with air conditioning

2. Recover the air conditioning (A/C) refrigerant.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

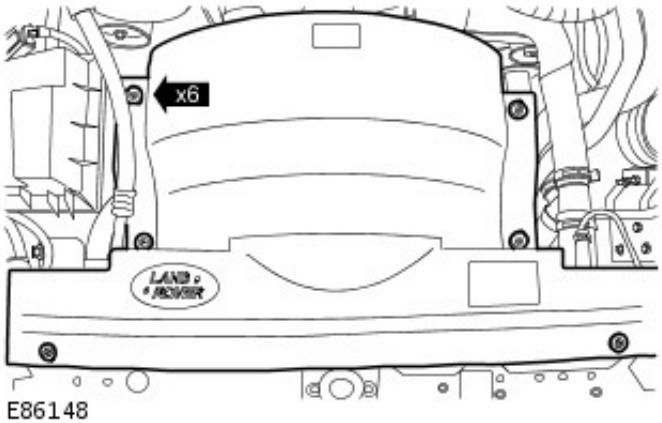


3. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Disconnect the A/C compressor low-pressure and high-pressure refrigerant lines.

   - Remove the bolt.
   - Remove and discard the O-ring seal.

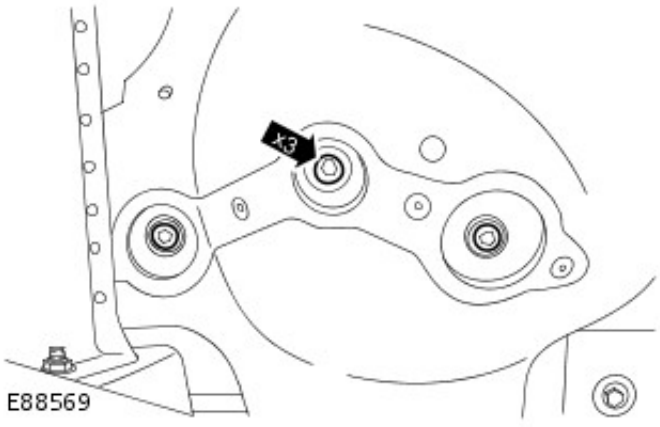
All vehicles



4. Remove the cooling fan upper shroud.
   - Release the 6 clips.

5. Remove the air cleaner element.
   For additional information, refer to: Air Cleaner Element (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

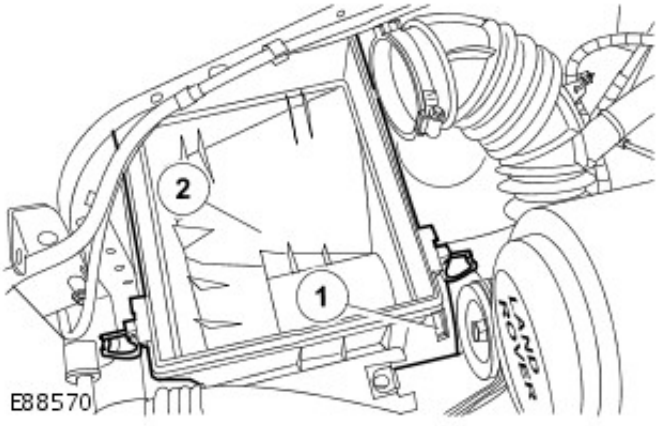
6. Release the air cleaner.



- Remove the 3 bolts.

7. Remove the air cleaner.

1. Disconnect the air cleaner intake pipe.
2. Remove the air cleaner.

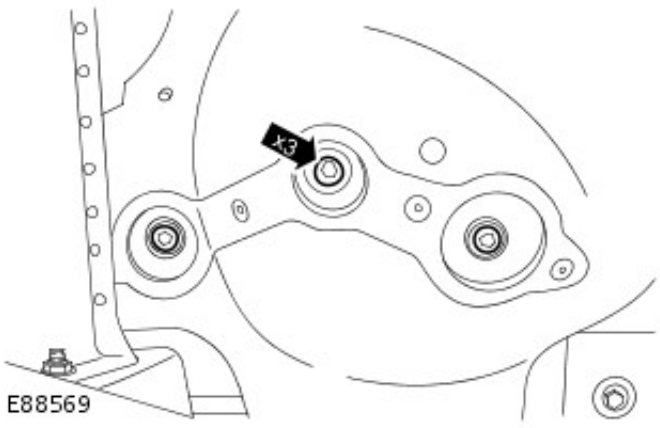


Installation

All vehicles

1. To install, reverse the removal procedure.

- Tighten to 13 Nm (10 lb.ft).



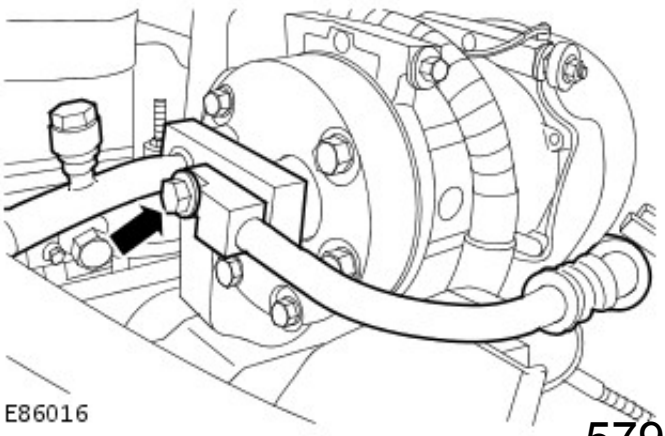
Vehicles with air conditioning

2. NOTE: Coat the compressor O-ring seals in clean refrigerant oil prior to installation.

• NOTE: Remove and discard the blanking caps.

Tighten to 30 Nm (22 lb.ft).

- Install new O-ring seals.



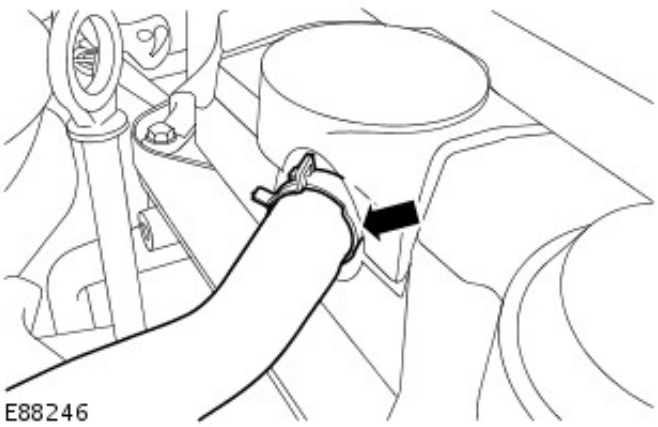
All vehicles

3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Air Cleaner Outlet Pipe

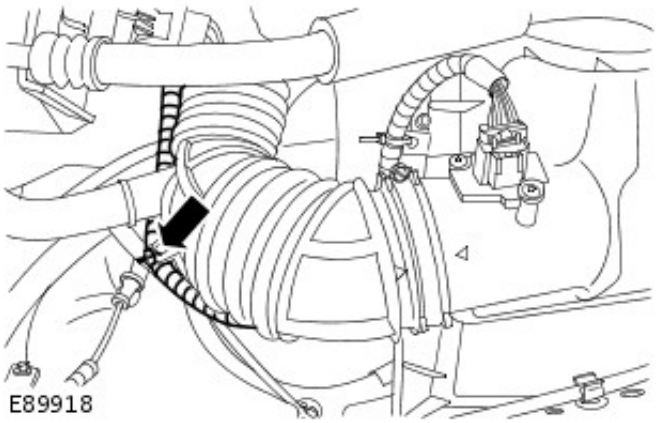
Removal and Installation

Removal

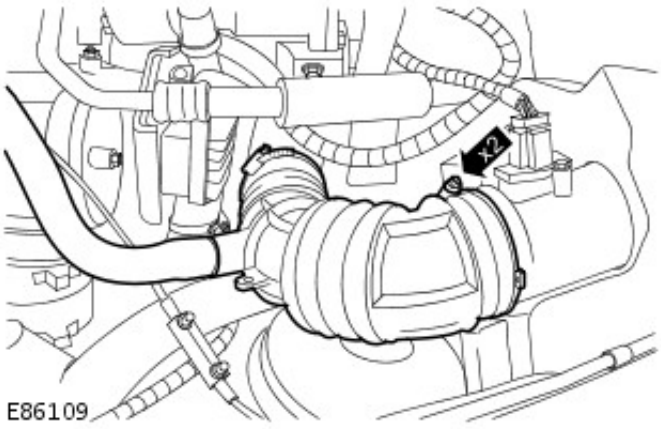


1. Release the positive crankcase ventilation (PCV) hose from the valve cover.

- Release the clip.



2. Release the mass air flow (MAF) sensor wiring harness.



3. Remove the air cleaner outlet pipe.

- Release the 2 clips.

Installation

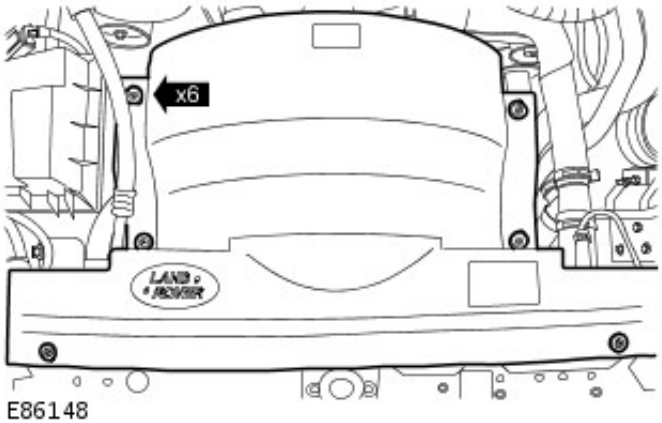
1. To install, reverse the removal procedure.

Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Charge Air Cooler

Removal and Installation

Removal

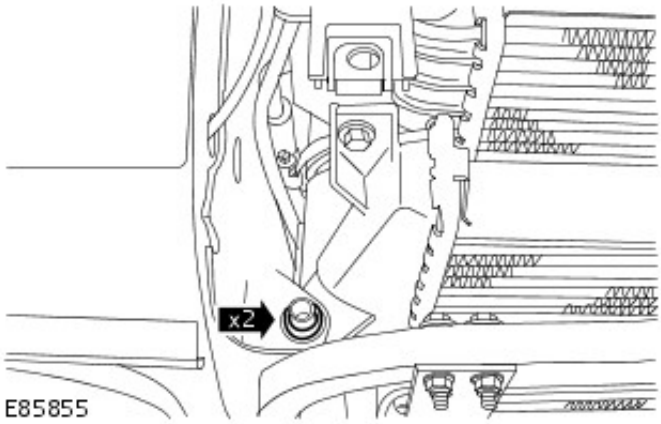
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the radiator grille.
   For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).
3. Remove the cooling fan upper shroud.
   - Release the 6 clips.



E86148

4. Remove the hood latch panel.
   For additional information, refer to: Hood Latch Panel (501-27 Front End Sheet Metal Repairs, Removal and Installation).
5. NOTE: RH shown, LH similar.

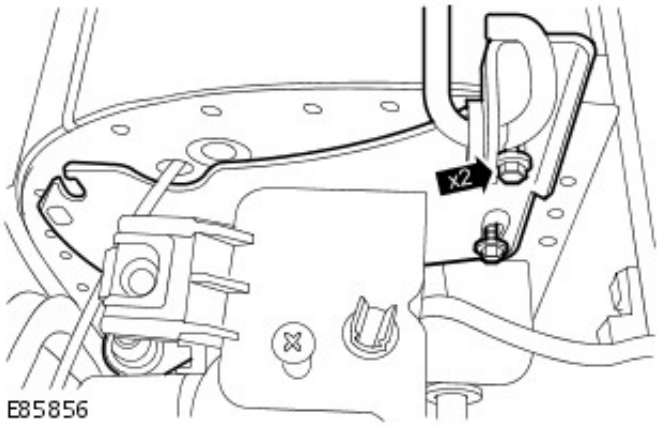
   Remove the 2 O-rings.



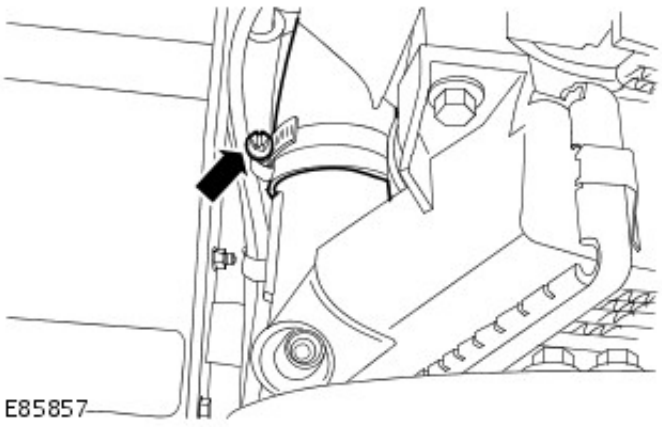
E85855

6. NOTE: RH shown, LH similar.

   Remove the 2 charge air cooler brackets.
   - Remove the 4 bolts.



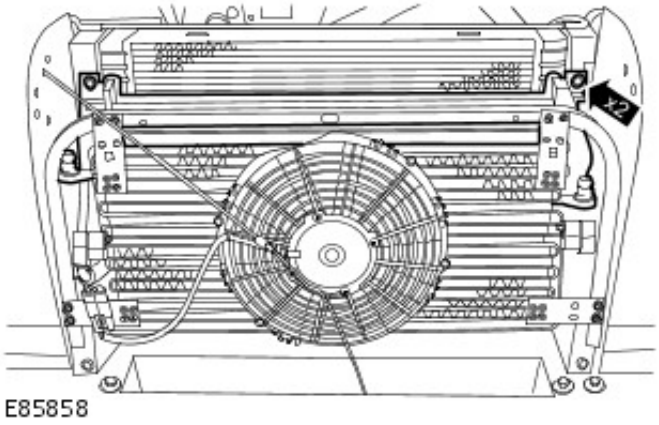
E85856



7. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

• NOTE: RH shown, LH similar.

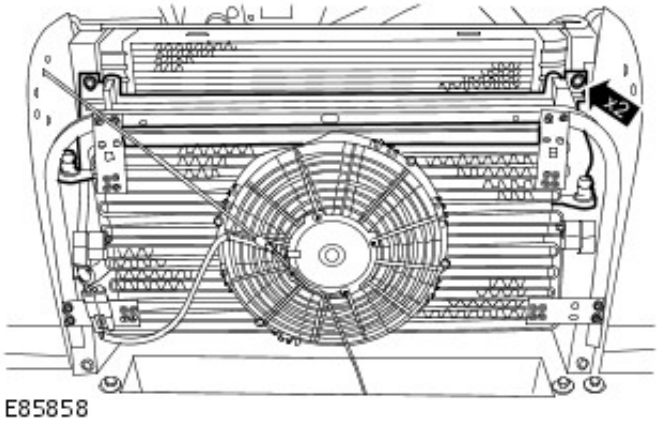
Disconnect the charge air cooler inlet hose and charge air cooler outlet hose.



8. Remove the charge air cooler.

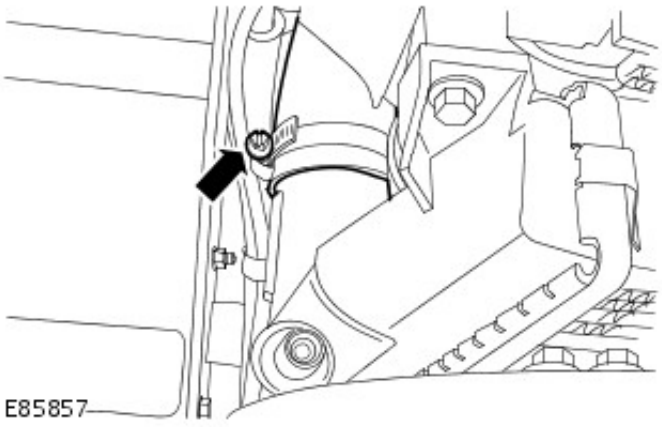
- Remove the 2 bolts.

Installation



1. To install, reverse the removal procedure.

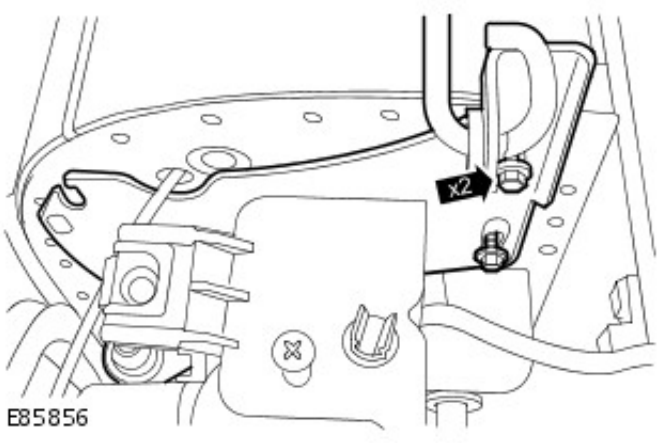
- Tighten to 20 Nm (15 lb.ft).



2. NOTE: Remove and discard the blanking caps.

Tighten to 3 Nm (2 lb.ft).

3. Tighten to 9 Nm (7 lb.ft).



4. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

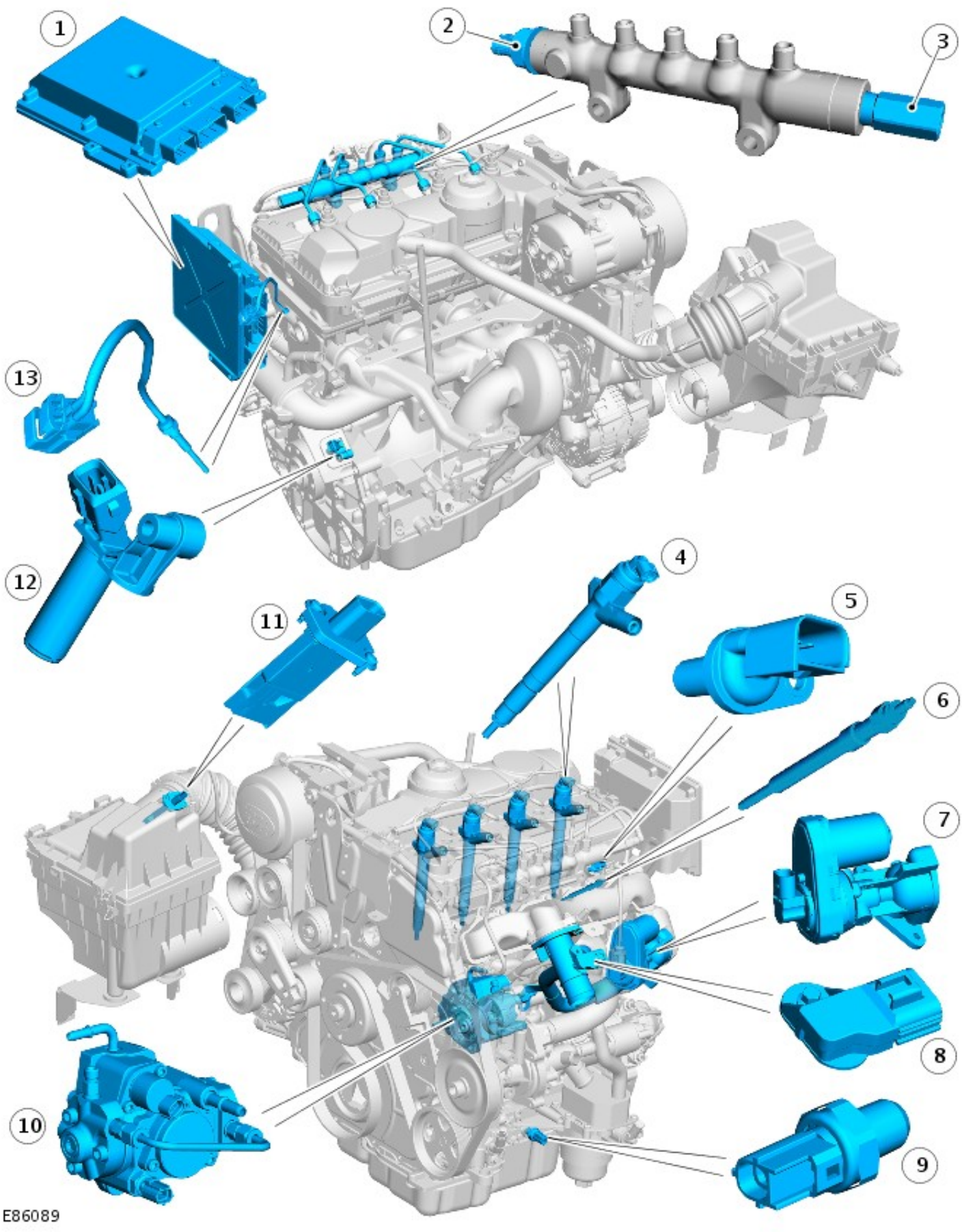
Torque Specifications

Item	Nm	lb-ft
Crankshaft position (CKP) sensor	7	5
Camshaft position (CMP) sensor	9	7
Cylinder head temperature (CHT) sensor	10	7
Manifold absolute pressure and temperature (MAPT) sensor	3	2
Engine oil pressure (EOP) sensor	15	11
Engine control module (ECM)	10	7

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Electronic Engine Controls

Description and Operation

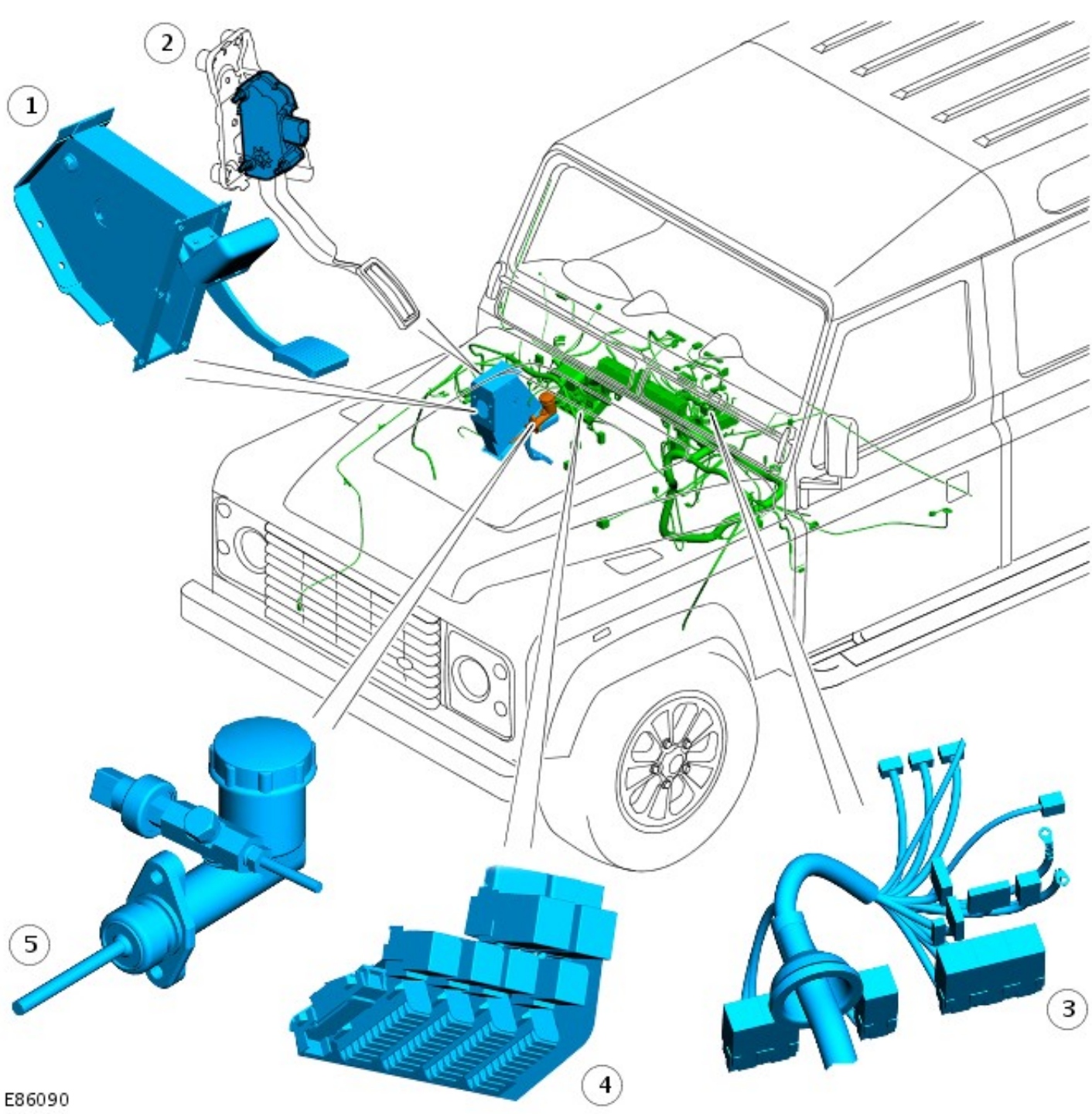
COMPONENT LOCATION SHEET 1



Item	Part Number	Description

1	-	engine control module (ECM)
2	-	Fuel pressure sensor
3	-	Pressure limiting valve
4	-	Injectors
5	-	camshaft position (CMP) sensor
6	-	Glow plugs
7	-	exhaust gas recirculation (EGR) valve
8	-	manifold absolute pressure (MAP) sensor
9	-	Oil pressure switch
10	-	Fuel pump
11	-	mass air flow (MAF)/intake air temperature (IAT) sensor
12	-	crankshaft position (CKP) sensor
13	-	cylinder head temperature (CHT) sensor

COMPONENT LOCATION SHEET 2



Item	Part Number	Description
1	-	Brake pedal switch
2	-	accelerator pedal position (APP) sensor
3	-	battery junction box (BJB)

4	-	central junction box (CJB)
5	-	Clutch switch

OVERVIEW

The engine management system is controlled by an ECM and is able to monitor, adapt and precisely control the fuel injection. The ECM uses multiple sensor inputs and precision control of actuators to achieve optimum performance during all driving conditions.

The ECM controls fuel delivery to all 4 cylinders via a Common Rail (CR) injection system. The CR system uses a fuel rail to accumulate highly pressurized fuel and feed the 4, electronically controlled injectors. The fuel rail is located in close proximity to the injectors, which assists in maintaining full system pressure at each injector at all times.

The ECM uses the drive by wire principle for acceleration control. There are no control cables or physical connections between the accelerator pedal and the engine. Accelerator pedal demand is communicated to the ECM by two potentiometers located in an APP sensor. The ECM uses the two signals to determine the position, rate of movement and direction of movement of the pedal. The ECM then uses this data, along with other engine information from other sensors, to achieve the optimum engine response.

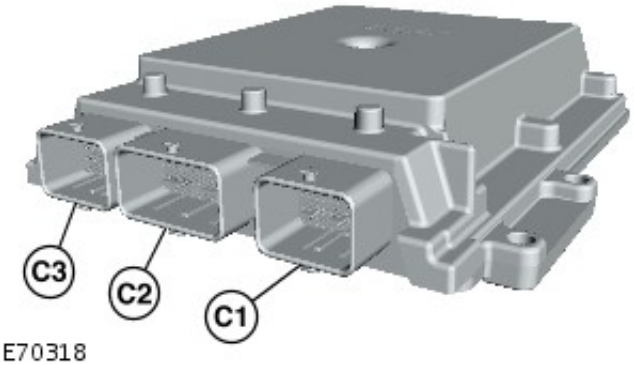
The ECM processes information from the following input sources:

- CKP sensor
- CMP sensor
- Manifold air temperature and pressure
- Cylinder head temperature
- Oil pressure
- Inlet air flow and temperature
- Fuel temperature

The ECM outputs controlling signals to the following sensors and actuators:

- Fuel injectors
- Cooling fan solenoid
- Electric vane controlled turbo
- Fuel pressure control valve
- Fuel volume control valve
- Electronic EGR
- Glow plugs

ECM



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Item	Part Number	Description
C1	-	Connector 1
C2	-	Connector 2
C3	-	Connector 3

The ECM connected to the vehicle harnesses via three connectors. The ECM contains data processors and memory microchips. The output signals to the actuators are in the form of ground paths provided by driver circuits within the ECM. The ECM driver circuits produce heat during normal operation and dissipate this heat via the casing. Some sensors receive a regulated voltage supplied by the ECM. This avoids incorrect signals caused by voltage drop during cranking.

The ECM performs self diagnostic routines and stores fault codes in its memory. These fault codes and diagnostics can be accessed using the Land Rover recommended diagnostic tool. If the ECM is to be replaced, the new ECM is supplied 'blank' and must be configured to the vehicle using the Land Rover recommended diagnostic tool. A 'flash' electrically erasable programmable read only memory (EEPROM) allows the ECM to be externally configured, using the Land Rover recommended diagnostic tool, with market specific or new tune information up to 14 times. If a fifteenth update is required the ECM must be replaced. The current engine tune data can be accessed and read using the Land Rover recommended diagnostic tool.

When a new ECM is fitted, it must also be synchronized to the immobilization control module using the Land Rover recommended diagnostic tool. ECM's cannot be 'swapped' between vehicles.

The ECM is connected to the engine sensors which allow it to monitor the engine operating conditions. The ECM processes these signals and decides the actions necessary to maintain optimum engine performance in terms of driveability, fuel efficiency and exhaust emissions. The memory of the ECM is programmed with instructions for how to control the engine, this known as the strategy. The memory also contains data in the form of maps which the ECM uses as a basis for fueling and emission control. By comparing the information from the sensors to the to the data in the maps, the ECM is able to calculate the various output requirements. The ECM contains an adaptive strategy which updates the system when components vary due to production tolerances or ageing.

The ECM receives a vehicle speed signal . Vehicle speed is an important input to the ECM strategies. The frequency of this signal changes according to road speed.

CRANKSHAFT POSITION SENSOR (CKP)

E86091

The CKP sensor is located at the rear of the engine block on the left hand side. The sensor tip is aligned with a magnetic trigger which is attached to the crankshaft. The reluctor is a press fit on the end of the crankshaft. The trigger wheel must be carefully aligned to the crankshaft to ensure correct timing. The sensor produces a square wave signal, the frequency of which is proportional to engine speed.

The ECM monitors the CKP sensor signal and can detect engine over-speed. The ECM counteracts engine over-speed by gradually fading out speed synchronized functions. The CKP sensor is a Hall effect sensor. The sensor measures the magnetic field variation induced by the magnetized trigger wheel.

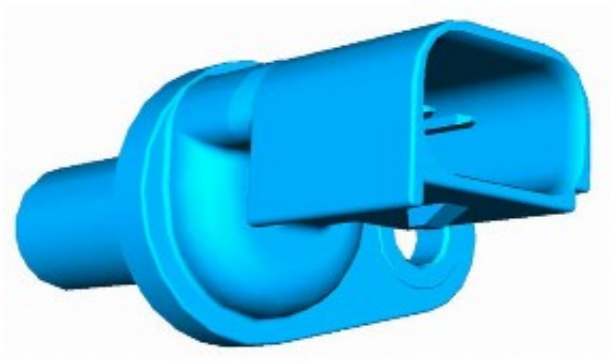
The trigger wheel has two missing teeth representing 12º of crankshaft rotation. The two missing teeth provide a reference point for the angular position of the crankshaft.

When the space with the two missing teeth pass the sensor tip, a gap in the signal is produced which the ECM uses to determine the crankshaft position. The air gap between the sensor tip and the ring is important to ensure correct signals are output to the ECM. The recommended air gap between the CKP sensor and the trigger wheel is 0.4 mm- 1.5 mm.

The ECM uses the signal from the CKP sensor for the following functions:

- Synchronisation.
- Determine fuel injection timing.
- Enable the fuel pump relay circuit (after the priming period).
- Produce an engine speed signal which is broadcast on the controller area network (CAN) bus for use by other systems.

CMP



E86092

The CMP is located towards the rear of the left hand side of the cylinder head. The sensor tip protrudes through the face to pick up on the reluctor behind the camshaft pulley.

The sensor is a Hall effect sensor which used by the ECM at engine start-up to synchronize the ECM with the CKP sensor signal. The ECM does this by using the CMP sensor signal to identify number one cylinder to ensure the correct injector timing. Once the ECM has established the injector timing, the CMP sensor signal is no longer used.

The CMP sensor receives a 5V supply from the ECM. Two further connections to the ECM provide ground and signal output.

If a fault occurs, an error is registered in the ECM. Two types of failure can occur; camshaft signal frequency too high or total failure of the camshaft signal. The error recorded by the ECM can also relate to a total failure of the crankshaft signal or crankshaft signal dynamically implausible. Both components should be checked to determine the cause of the fault.

If a fault occurs with the CMP sensor when the engine is running, the engine will continue to run but the ECM will deactivate boost pressure control. Once the engine is switched off, the engine will crank but will not restart while the fault is present.

GLOW PLUGS

E46912

Four glow plugs are located in the cylinder head, on the inlet side. The glow plugs and the glow plug relay are a vital part of the engine starting strategy. The glow plugs heat the air inside the cylinder during cold starts to assist combustion. The use of glow plugs helps reduce the amount of additional fuel required on start-up, and consequently reduces the emission of black smoke. The use of glow plugs also reduces the amount of injection advance required, which reduces engine noise, particularly when idling with a cold engine.

There are three phases of glow plug activity:

- Pre-heat
- During crank
- Post heat

The main part of the glow plug is a tubular heating element which protrudes into the combustion chamber of the engine. The heating element contains a spiral filament encased in magnesium oxide powder. At the tip of the tubular heating element is the heater coil. Behind the heater coil, and connected in series, is a control coil. The control coil regulates the heater coil to ensure that it does not overheat.

Pre-heat is the length of time the glow plugs operate prior to engine cranking. The ECM controls the pre-heat time based on engine coolant temperature (ECT) sensor output and battery voltage. If the ECT sensor fails, the ECM will use the IAT sensor value as a default value. The pre-heat duration is extended if the coolant temperature is low and the battery is not fully charged.

Post heat is the length of time the glow plugs operate after the engine starts. The ECM controls the post heating time based on ECT sensor output. The post heat phase reduces engine noise, improves idle quality and reduces hydrocarbon emissions.

When the ignition is switched on to position II, the glow plug warning lamp illuminates in the instrument cluster. The glow-lamp is activated separately from the glow-plugs, so is not illuminated during or after start. The plugs can still be ON when the lamp is off in these two phases.

In the event of glow plug failure, the engine may be difficult to start and excessive smoke emissions may be observed after starting.

The glow plug warning lamp also serves a second function within the EDC system. If a major EDC system fault occurs, the glow plug warning lamp will be illuminated until the fault is rectified. The driver must seek attention to the engine management system at a Land Rover dealer as soon as possible.

INJECTORS

There are 4 electronic fuel injectors (one for each cylinder) located in a central position between the four valves of each cylinder. The ECM divides the injectors into two banks of 4 with cylinders.

Each injector is supplied with pressurized fuel from the fuel rail and delivers finely atomized fuel directly into the combustion chambers. Each injector is individually controlled by the ECM which operates each injector in the firing order and controls the injector opening period via pulse width modulation (PWM) signals. Each injector receives a 12V supply from the ECM and, using programmed injection/timing maps and sensor signals, determines the precise pilot and main injector timing for each cylinder. If battery voltage falls to between 6 and 9V, fuel injector operation is restricted, affecting emissions, engine speed range and idle speed. In the event of a failure of a fuel injector, the following symptoms may be observed:

- Engine misfire
- Idle irregular
- Reduced engine performance
- Reduced fuel economy
- Difficult starting
- Increased smoke emissions.

The ECM monitors the wires for each injector for short circuit and open circuit, each injector and the transient current within the ECM. If a defect is found, an error is registered in the ECM for the injector in question.

CHT SENSOR

The CHT sensor is located in the top hose at the coolant manifold junction. The ECT sensor provides the ECM and the instrument cluster with engine coolant temperature status.

The ECM uses the temperature information for the following functions:

- Fueling calculations
- Limit engine operation if engine coolant temperature becomes too high
- Cooling fan operation
- Glow plug activation time.

The instrument cluster uses the temperature information for temperature gauge operation. The CHT signal is also transmitted on the CAN bus by the instrument cluster for use by other systems.

The ECMCHT sensor circuit consists of an internal voltage divider circuit which incorporates an negative temperature coefficient (NTC) thermistor. As the CHT rises the resistance through the sensor decreases and vice versa. The output from the sensor is the change in voltage as the thermistor allows more current to pass to earth relative to the temperature of the coolant.

The ECM compares the signal voltage to stored values and adjusts fuel delivery to ensure optimum driveability at all times. The engine will require more fuel when it is cold to overcome fuel condensing on the cold metal surfaces inside

the combustion chamber. To achieve a richer air/fuel ratio, the ECM extends the injector opening time. As the engine warms up the air/fuel ratio is leaned off.

The input to the sensor is a 5V reference voltage supplied from the voltage divider circuit within the ECM. The ground from the sensor is also connected to the ECM which measures the returned current and calculates a resistance figure for the sensor which relates to the coolant temperature.

The following table shows CHT values and the corresponding sensor resistance and voltage values.

Coolant Temperature Sensor Response

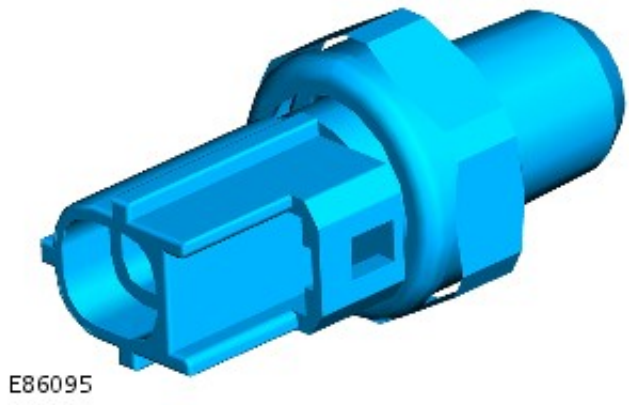
Temperature (Degrees Celsius)	Resistance (Kohms)	Voltage (Volts)
-40	925	4.54
-30	496	4.46
-20	277	4.34
-10	160	4.15
0	96	3.88
10	59	3.52
20	37	3.09
30	24	2.62
40	16	2.15
50	11	1.72
60	7.5	1.34
70	5.6	1.04
80	3.8	0.79
90	2.9	0.64
100	2.08	0.49
110	1.56	0.38
120	1.19	0.29
130	0.918	0.22
140	0.673	0.17
150	0.563	0.14

If the CHT sensor fails, the following symptoms may be observed:

- Difficult cold start.
- Difficult hot start.
- Engine performance compromised.
- Temperature gauge inoperative or inaccurate reading.

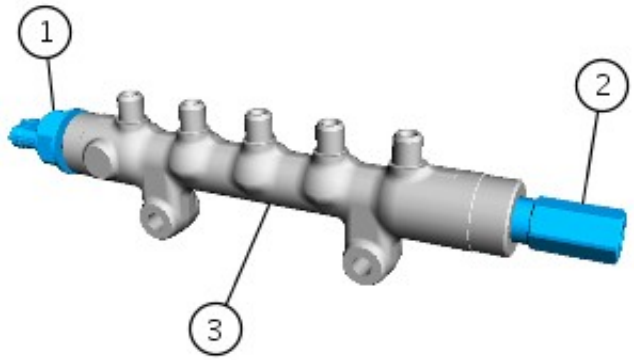
In the event of CHT sensor signal failure, the ECM applies a default value of 80°Celsius (176°F) coolant temperature for Fueling purposes. The ECM will also permanently operate the cooling fan at all times when the ignition is switched on, to protect the engine from overheating.

OIL PRESSURE SWITCH



The oil pressure switch, located in the oil cooler assembly, connects a ground input to the instrument cluster when oil pressure is present. The switch operates at a pressure of 0.15 to 0.41 bar (2.2 to 5.9 Psi).

FUEL RAIL PRESSURE SENSOR



E69911

Item	Part Number	Description
1	-	Fuel pressure sensor
2	-	Pressure limiting valve
3	-	Fuel rail

The fuel rail pressure sensor is located forward end of the fuel rail. The fuel rail pressure sensor measures the pressure of the fuel in the fuel rail. This input is then used by the ECM to control the amount of fuel delivered to the fuel rail.

FUEL RAIL PRESSURE RELIEF VALVE

The fuel rail pressure relief valve is located at the rear end of the fuel rail. To prevent damage to the high pressure fuel system, the valve opens when the fuel pressure in the rail reaches approximately 2000 bar. The ECM detects the valve opening and sends a malfunction indicator lamp (MIL) request to the instrument cluster.

Once the valve has been opened it needs to be replaced.

FUEL TEMPERATURE SENSOR

The fuel temperature sensor is located in the high pressure fuel pump.

The sensor is an NTC sensor which is connected to the ECM by two wires. The ECM fuel temperature sensor circuit consists of an internal voltage divider circuit which incorporates an NTC thermistor. As the fuel temperature rises the resistance through the sensor decreases. The output from the sensor is the change in voltage as the thermistor allows more current to pass to earth relative to the temperature of the fuel.

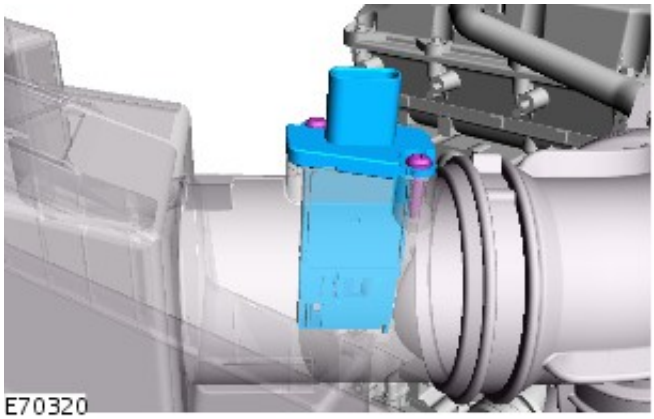
The ECM monitors the fuel temperature constantly. If the fuel temperature exceeds 85°Celsius (185°F), the ECM invokes an engine 'derate' strategy. This reduces the amount of fuel delivered to the injectors in order to allow the fuel to cool. When this occurs, the driver may notice a loss of performance.

Further fuel cooling is available by a bi-metallic valve diverting fuel through the fuel cooler when the fuel reaches a predetermined temperature. In hot climate markets, an electrically operated cooling fan is positioned in the air intake ducting to the fuel cooler. This is controlled by a thermostatic switch, which switches the fan on and off when the fuel reaches a predetermined temperature.

The wires to the fuel sensor are monitored by the ECM for short and open circuit. The ECM also monitors the 5V supply. If a failure occurs a fault is recorded in the ECM memory and the ECM uses a default fuel pressure value.

If the ECM registers an 'out of range' deviation between the pressure signal from the sensor and the pre-programmed 'set point' a fault is stored in the ECM memory. Depending on the extent of the deviation, the ECM will reduce the injection quantity, stop the engine immediately or prevent further engine starting.

MAF SENSOR



E70320

Two MAF sensor is located on the intake air duct directly after the air filter box. The sensor is housed in a plastic molding which is connected between the intake manifold and the air intake pipe.

The MAF sensor works on the hot film principle. Two sensing elements are contained within a film. One element is maintained at ambient (air intake) temperature, e.g. 25°Celsius (77°F). The other element is heated to 200°Celsius (392°F) above the ambient temperature, e.g. 225°Celsius (437°F). Intake air entering the engine passes through the MAF sensor and has a cooling effect on the film. The ECM monitors the current required to maintain the 200°Celsius (392°F) differential between the two elements and uses the differential to provide a precise, non-linear, frequency based signal which equates to the volume of air being drawn into the engine.

The MAF sensor output is a digital signal proportional to the mass of the incoming air. The ECM uses this data, in conjunction with signals from other sensors and information from stored fueling maps, to determine the precise fuel quantity to be injected into the cylinders. The signal is also used as a feedback signal for the EGR system.

The MAF sensor receives a 12V supply from the BJB and a ground connection via the ECM. Two further connections to the ECM provide a MAF signal and IAT signal.

The ECM checks the calculated air mass against the engine speed. If the calculated air mass is not plausible, the ECM uses a default air mass figure which is derived from the average engine speed compared to a stored characteristic map. The air mass value will be corrected using values for boost pressure, atmospheric pressure and air temperature.

If the MAF sensor fails the ECM implements the default strategy based on engine speed. In the event of a MAF sensor signal failure, any of the following symptoms may be observed:

- Difficult starting
- Engine stalls after starting
- Delayed engine response
- Emission control inoperative
- Idle speed control inoperative
- Reduced engine performance.

manifold absolute pressure and temperature (MAPT) SENSOR

E86097

The MAPT sensor is located post turbo after the electric throttle valves. The sensor provides a voltage signal to the ECM relative to the intake manifold pressure. The MAPT sensor has a three pin connector which is connected to the ECM and provides a 5V reference supply from the ECM, a signal input to the ECM and a ground for the sensor.

The MAPT sensors uses diaphragm transducer to measure pressure. The ECM uses the BP sensor signal for the following functions:

- Maintain manifold boost pressure.
- Reduce exhaust smoke emissions when driving at high altitude.
- Control of the EGR system.
- Control of the vacuum control module.

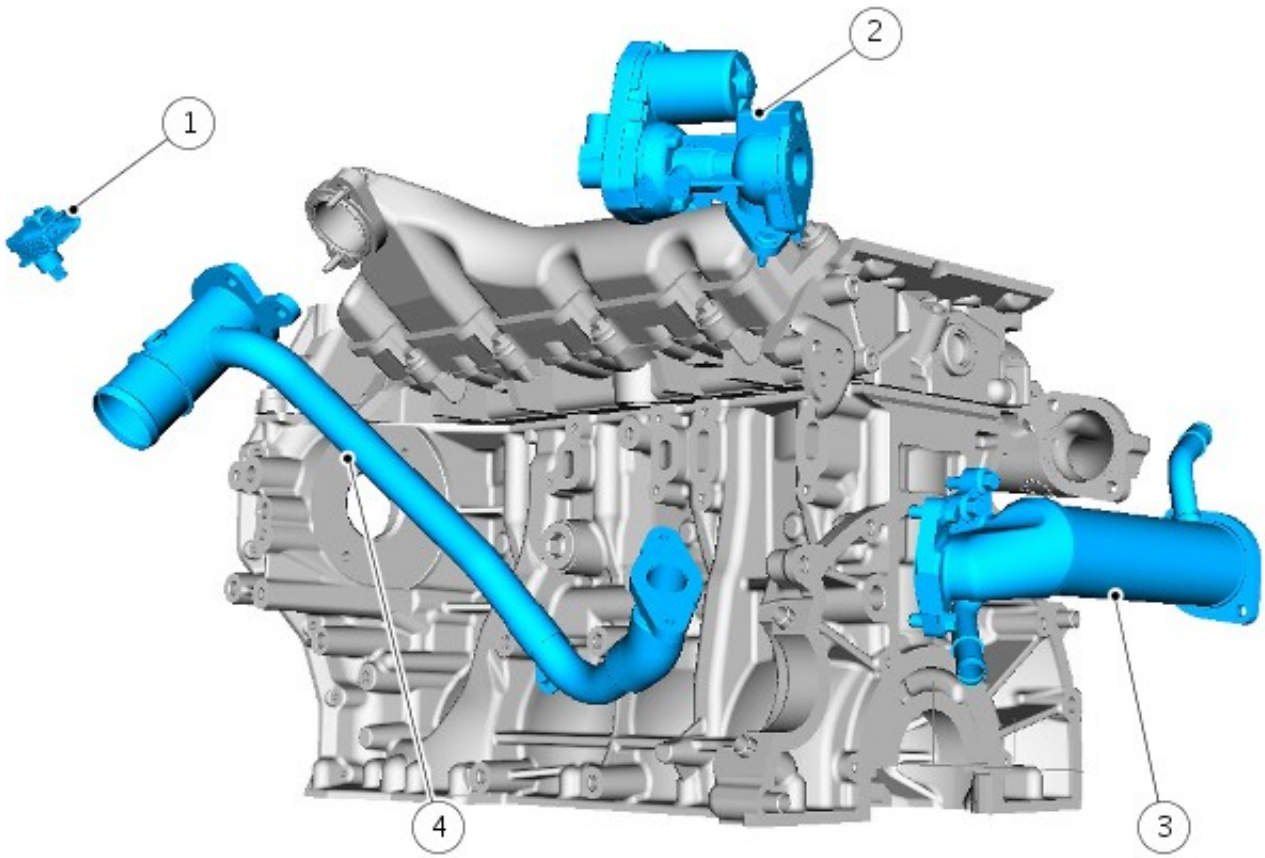
If the MAPT sensors fail, the ECM uses a default pressure of 1013 mbar (14 lbf/in²). In the event of a MAPT sensor failure, the following symptoms may be observed:

- Altitude compensation inoperative (black smoke emitted from the exhaust).
- Active boost control inoperative.

Boost control is achieved by the use of a direct drive electric actuator. The actuator is attached to the side of the turbo unit and is connected with the control mechanism via a linkage. The electric actuator works on the torque motor principal and has integrated control module.

The electric actuator moves the control vanes through an 60 degree stroke and has the capability to learn its own maximum stroke positions. The electric actuator is controlled via PWM signals from the ECM.

EGR SYSTEM



E63622

Item	Part Number	Description
1	-	MAPT Sensor
2	-	EGR unit
3	-	EGR cooler
4	-	Connecting pipe

The EGR system comprises:

- EGR modulator x 2
- EGR cooler x 2
- Associated connecting pipes

The EGR modulator and cooler are a combined unit.

The combined EGR modulator and cooler is located under each cylinder bank, between the exhaust manifold and the cylinder head. The cooler side of the EGR is connected to the vehicle cooling system, via hoses. The inlet exhaust side is connected directly into the exhaust manifolds on each side. The exhaust gas passes through the cooler and is expelled via the actuator and a metal pipe into the throttle housing. The EGR modulator is a solenoid operated valve which is controlled by the ECM. The ECM uses the EGR modulator to control the amount of exhaust gas being re-circulated in order to reduce exhaust emissions and combustion noise. The EGR is enabled when the engine is at normal operating temperature and under cruising conditions.

The EGR modulator receives a 12V supply from the ECM and is controlled using a PWM signal. The PWM duty signal of the solenoid ground is varied to determine the precise amount of exhaust gas delivered to the cylinders.

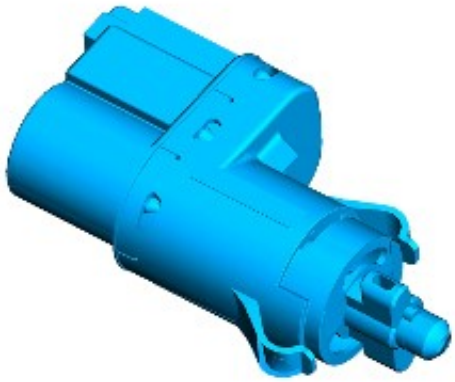
The modulators are operated through their full range at each engine shut down, to clear any carbon deposits that may have built up whilst the engine was running

In the event of a failure of the EGR modulator, the EGR function will become inoperative. The ECM can monitor the EGR modulator solenoid for short circuits and store fault codes in the event of failure. The modulator can also be activated for testing using the Land Rover recommended diagnostic tool.

FUEL VOLUME CONTROL VALVE

The fuel rail volume control valve is incorporated into the high pressure fuel pump. The VCV spills unwanted fuel back to the tank (or LP system) or forwards it to the PCV. This avoids unused fuel being pressurized by the HP stage of the pump, only to be spilt back to LP by the PCV wasting energy and heating the fuel.

BRAKE LAMP SWITCHES



E86098

The brake switch is located on the pedal box and is operated by the brake pedal. The switch is a Hall effect switch which detects the position of the brake pedal and determines when the driver has applied the brakes. The switch is connected directly to the ECM.

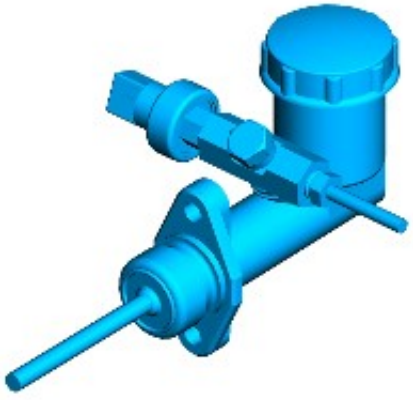
The brake switch consists of an inner sensor in an outer mounting sleeve. To ensure correct orientation, the sensor is keyed to the mounting sleeve and the mounting sleeve is keyed to the pedal mounting bracket. Mating serrations hold the sensor in position in the mounting sleeve. While the brakes are off, the tang on the brake pedal rests against the end of the sensor. When the brake pedal is pressed, the tang moves away from the sensor and induces a change of sensor output voltages. This is sensed by the ECM which detects that the brake pedal has been applied. The ECM uses the brake signal for the following:

- To limit fueling during braking
- To inhibit/cancel speed control if the brakes are applied.

In the event of a brake switch failure, the following symptoms may be observed:

- Speed control inactive
- Increased fuel consumption.

CLUTCH SWITCH



E86100

The clutch switch is located on the clutch master cylinder. The clutch switch is a pressure transducer type. When the clutch is depressed the clutch switch sends a signal to the ECM which reduces engine torque.

GENERATOR

E86099

The generator has a multifunction voltage regulator for use in a 14V charging system with 6÷12 zener diode bridge rectifiers.

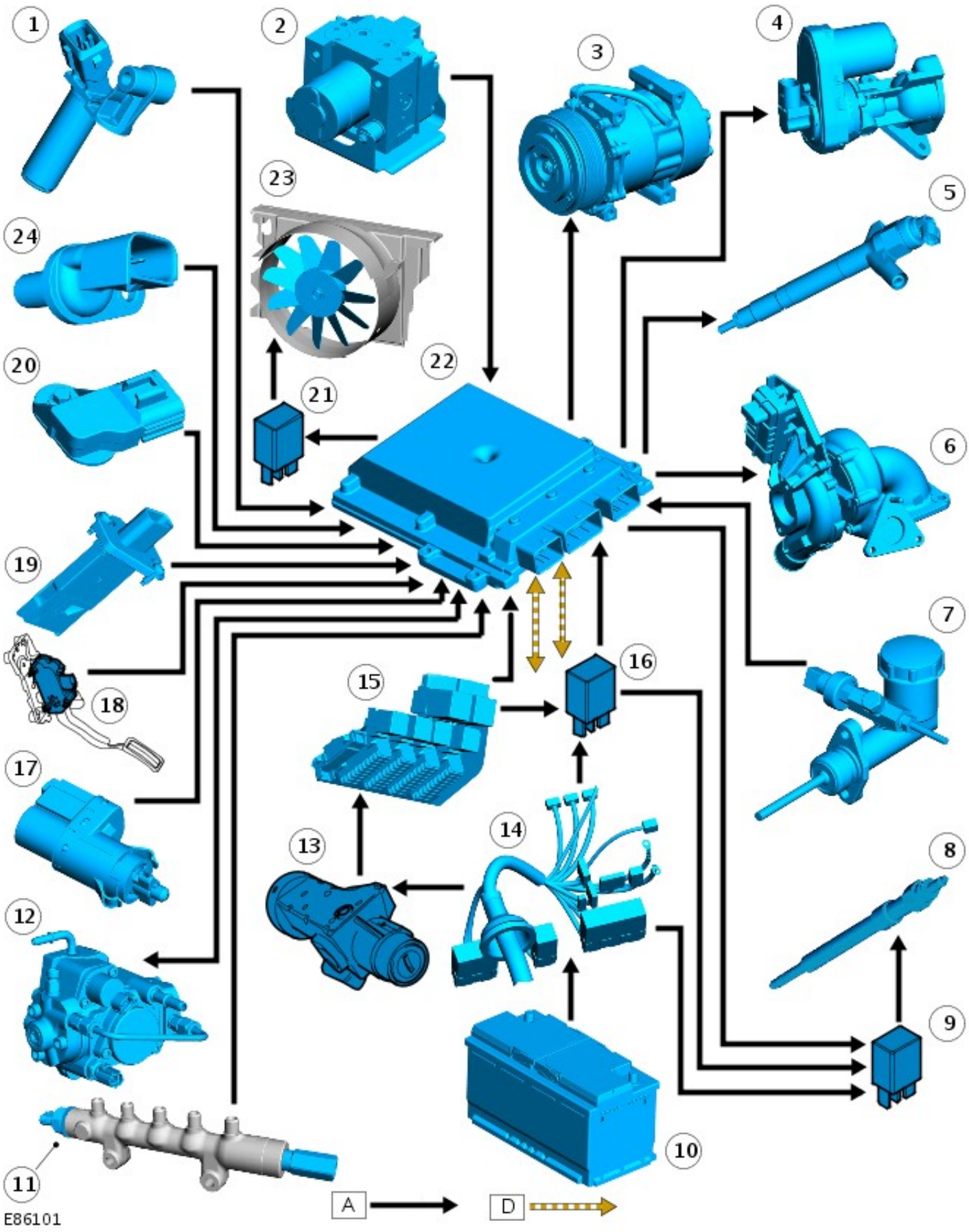
The ECM monitors the load on the electrical system via PWM signal and adjusts the generator output to match the required load. The ECM also monitors the battery temperature to determine the generator regulator set point. This characteristic is necessary to protect the battery; at low temperatures battery charge acceptance is very poor so the voltage needs to be high to maximize any recharge ability, but at high temperatures the charge voltage must be restricted to prevent excessive gassing of the battery with consequent water loss.

The generator has a smart charge capability that will reduce the electrical load on the generator reducing torque requirements, this is implemented to utilize the engine torque for other purposes. This is achieved by monitoring three signals to the ECM:

- Generator sense (A sense), measures the battery voltage at the CJB.
- Generator communication (Alt Com) communicates desired generator voltage set point from ECM to generator.
- Generator monitor (Alt Mon) communicates the extent of generator current draw to ECM. This signal also transmits faults to the ECM which will then sends a message to the instrument cluster on the CAN bus to illuminate the charge warning lamp.

CONTROL DIAGRAM

• NOTE: A = Hardwired; D = High speed CAN



Item	Part Number	Description
1	-	CKP
2	-	anti-lock brake system (ABS) module
3	-	Air conditioning compressor
4	-	EGR valve
5	-	injectors
6	-	Turbocharger

7	-	Clutch switch
8	-	Glow plugs
9	-	Glow plug relay
10	-	Battery
11	-	Fuel rail pressure sensor
12	-	Fuel pump
13	-	Ignition switch
14	-	BJB
15	-	CJB
16	-	Glow plug relay
17	-	Brake pedal switch
18	-	APP
19	-	MAF/IAT sensor
20	-	MAP sensor
21	-	Electric fan relay
22	-	ECM
23	-	Cooling fan
24	-	CMP sensor

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Electronic Engine Controls

Diagnosis and Testing

Overview

This section covers the components of the engine management system.

For information on description and operation:
REFER to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Inspection and Verification

1. **1.** Verify the customer concern.
2. **2.** Visually inspect for obvious mechanical or electrical faults.

Visual Inspection Chart

Mechanical	Electrical
• Engine oil level • Cooling system coolant level • Fuel level/contamination • Fuel leaks • Fuel injection pump • Intake air system • Accessory drive belt • Sensor fitment/condition • Cooling fan	• Fuses - Fuse P110 - Fuse 41, engine compartment junction box • Wiring harness • Electrical connector(s) • Injectors • Glow plugs • 5 volt sensor supply • Sensor(s) • Engine control module (ECM)

3. **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. **4.** Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.
    - Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible causes	Action
Engine does not crank	• Starter relay output circuit: high resistance • Starter relay output circuit: short circuit to power • Starter motor fault • Ignition switch fault • Controller area network (CAN) fault	Check the starter relay and circuits. Refer to the electrical guides. Check the ignition switch operation. Check for DTCs indicating a CAN fault.
Engine cranks, but does not start	• Inertia fuel shutoff (IFS) switch • Main engine control module (ECM) relay fault • Low/contaminated fuel • Air leakage • Low-pressure fuel system fault • Blocked fuel filter • Suction control valve fault • Fuel injection pump fault • Crankshaft position (CKP) sensor	Check that the IFS has not tripped. Check the main ECM relay and circuits, refer to the electrical guides. Check the fuel level and condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel injection pump fault. Check the fuel injection pump: REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the CKP sensor circuits. Refer to the electrical guides. Install a new CKP sensor if necessary. REFER to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Difficult to start	• Glow plug system fault (very cold conditions) • Low/contaminated	

	• Low/contaminated fuel • Air leakage • Low-pressure fuel system fault • Blocked fuel filter • Suction control valve fault • Exhaust gas recirculation (EGR) valve fault	Check the glow plug circuits. Refer to the electrical guides. Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel injection pump fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Rough idle	• Intake air system fault • Low/contaminated fuel • Low-pressure fuel system fault • Blocked fuel filter • Suction control valve fault • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks. Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the low-pressure fuel system for leaks/damage. Check the fuel filter, check for DTCs indicating a fuel injection pump fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Lack of power when accelerating	• Intake air system fault • Restricted exhaust system • Low fuel pressure • Exhaust gas recirculation (EGR) valve fault • Turbocharger actuator fault	Check the intake air system for leakage or restriction. Check for a blockage/restriction in the exhaust system, install new components as necessary: REFER to: Catalytic Converter (309-00 Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check for DTCs indicating a fuel pressure fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing). For turbocharger actuator checks: REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Engine stops/stalls	• Air leakage • Low/contaminated fuel • Low-pressure fuel system fault • High-pressure fuel leak • Suction control valve fault • Exhaust gas recirculation (EGR) valve fault	Check the intake air system for leaks. Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the fuel system for leaks/damage. Check for DTCs indicating a fuel injection pump fault. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).
Engine judders	• Low/contaminated fuel • Air ingress • Low-pressure fuel system fault • Suction control valve fault • High-pressure fuel leak • Fuel injection pump fault	Check the fuel level/condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for leaks. Check the low-pressure fuel system for leaks/damage. Check the high-pressure fuel system for leaks, check for DTCs indicating a fuel injection pump fault. Check the fuel injection pump: REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
Excessive fuel consumption	• Low-pressure fuel system fault • Suction control valve fault • Fuel temperature sensor leak • High-pressure fuel leak • Injector(s) fault • Exhaust gas recirculation (EGR) valve fault	Check the low-pressure fuel system for leaks/damage. Check for DTCs indicating a fuel injection pump fault. Check the fuel temperature sensor, fuel injection pump, etc. for leaks. Check for injector DTCs. For EGR valve checks: REFER to: Engine Emission Control (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Diagnosis and Testing).

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

DTC	Description	Possible causes	Actions
P001600	Crankshaft position (CKP) sensor - camshaft position (CMP) sensor correlation - bank 1 sensor A	• Condition and fitment of the CKP sensor • Condition and fitment of the CMP sensor • Timing drive component fault • CKP sensor circuit: short circuit to other pins • CKP sensor circuit: open circuit • CMP sensor circuit: short circuit to other pins • CMP sensor circuit: open circuit • CKP sensor fault • CMP sensor fault	Check the condition and fitment of the CKP and CMP sensors (refer to the visual inspection). Check the timing drive components. Check the CKP and CMP sensors and circuits. Refer to the electrical guides. Install a new sensor if necessary. REFER to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation) / Camshaft Position (CMP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and check for normal operation.
P004611	Turbocharger boost control A circuit range/performance - circuit short to ground	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger fault	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P004612	Turbocharger boost control A circuit range/performance - circuit short to battery	• Turbocharger control solenoid circuit: short circuit to power • Turbocharger fault	
P00461A	Turbocharger boost control A circuit range/performance - circuit resistance below threshold	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger control solenoid circuit: short circuit to power • Turbocharger control solenoid circuit: open circuit • Turbocharger fault	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P00461B	Turbocharger boost control A circuit range/performance - circuit resistance above threshold	• Turbocharger control solenoid circuit: short circuit to ground • Turbocharger control solenoid circuit: short circuit to power • Turbocharger control solenoid circuit: open circuit • Turbocharger fault	
P006900	Manifold absolute pressure (MAP) sensor - barometric pressure correlation	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor	Check for related DTCs. Rectify as necessary. Using a

		• NOTE: Barometric pressure sensor is part of the engine control module (ECM) • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault • Barometric pressure sensor fault	data logger function check the barometric and manifold absolute pressure readings, both sensors should read approximately atmospheric pressure (ignition on, engine NOT running). A reading significantly higher or lower on one sensor would indicate a sensor fault. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and check for normal operation. Refer to the warranty policy and procedures manual, if a module is suspect.
P006A00	Manifold absolute pressure (MAP) sensor - mass or volume air flow correlation	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • Restricted air intake path • Exhaust gas recirculation (EGR) valve stuck open • Turbocharger fault • MAP sensor fault • Mass air flow (MAF) sensor fault	Check the intake air path for restrictions. Rectify as necessary. Check for DTCs indicating an EGR, turbocharger, MAPT or MAF sensor fault. Rectify as necessary. Clear the DTCs and check for normal operation.
P008807	Fuel rail/system pressure - too high	• Fuel rail pressure sensor to engine control module (ECM) wiring (supply/signal): short circuit to each other • Fuel rail pressure sensor to ECM signal circuit: short circuit to power • Fuel rail pressure sensor fault • Fuel injection pump circuit: short circuit to power • Fuel injection pump fault • Fuel rail pressure limiting valve	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor cannot be serviced separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and carry out a road test to confirm repair.
P008809	Fuel rail/system pressure - too high	• Fuel rail pressure sensor to engine control module (ECM) wiring (supply/signal): short circuit to each other • Fuel rail pressure sensor to ECM sensor circuit: short circuit to power • Fuel rail pressure sensor fault • Fuel injection pump circuit: short circuit to power • Fuel injection pump fault • Fuel rail pressure limiting valve	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor cannot be serviced separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and carry out a road test to confirm repair.
P00897A	Fuel pressure regulator performance	• Fuel rail pressure limiting valve has activated	The fuel rail pressure limiting valve operates as a disposable item in the event of excess system pressure. Once activated the valve cannot be guaranteed leak free

			and should be replaced. Install a new fuel rail pressure limiting valve. REFER to: Fuel Pressure Relief Valve (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
P009111	Fuel pressure regulator control circuit - circuit short to ground	• Fuel suction control valve circuit: short circuit to ground • Fuel suction control valve fault	Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009112	Fuel pressure regulator control circuit - circuit short to battery	• Fuel suction control valve circuit: short circuit to power • Fuel suction control valve fault	
P009211	Fuel pressure regulator control circuit - circuit short to ground	• Fuel suction control valve circuit: short circuit to ground • Fuel suction control valve fault	Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009212	Fuel pressure regulator control circuit - circuit short to battery	• Fuel suction control valve circuit: short circuit to power • Fuel suction control valve fault	
P00952F	Intake air temperature (IAT) sensor 2 circuit - signal erratic	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2 circuit: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009511	Intake air temperature (IAT) sensor 2 circuit - circuit short to ground	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: short circuit to ground • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P009515	Intake air temperature (IAT) sensor 2 circuit - circuit short to battery or open	• NOTE: The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor • IAT sensor 2: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2 fault	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010029	Mass or volume air flow A circuit - signal invalid	• Restricted air intake path • Check for leak between mass air flow (MAF) sensor and turbocharger • MAF sensor fault • Turbocharger fault • Exhaust gas	Check the intake air system for leaks, restrictions, etc. Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation.

		recirculation (EGR) valve fault	
P010036	Mass or volume air flow A circuit - signal frequency too low	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010037	Mass or volume air flow A circuit - signal frequency too high	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P010064	Mass or volume air flow A circuit - signal plausibility failure	• Mass air flow (MAF) sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the MAF sensor and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P01102F	Intake air temperature (IAT) sensor 1 circuit - signal erratic	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to power • IAT sensor 1 circuit: short circuit to ground • IAT sensor 1 circuit: open circuit • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011011	Intake air temperature (IAT) sensor 1 circuit - circuit short to ground	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to ground • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011015	Intake air temperature (IAT) sensor 1 circuit - circuit short to battery or open	• NOTE: The IAT sensor 1 is part of the mass air flow (MAF) sensor • IAT sensor 1 circuit: short circuit to power • IAT sensor 1 circuit: open circuit • IAT sensor 1 fault	Check the IAT sensor 1 and circuit. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P01152F	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - signal erratic	• CHT sensor circuit: short circuit to power • CHT sensor circuit: short circuit to ground • CHT sensor circuit: open circuit	

		• CHT sensor fault	Check the CHT sensor and circuit. Refer to the electrical guides. Install a new CHT sensor if necessary. REFER to: Cylinder Head Temperature (CHT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P011516	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - circuit voltage below threshold	• CHT sensor circuit: short circuit to ground • CHT sensor circuit: open circuit • CHT sensor fault	
P011517	Engine coolant temperature (ECT) (cylinder head temperature (CHT)) sensor 1 circuit - circuit voltage above threshold	• CHT sensor circuit: short circuit to power • CHT sensor fault	
P01208F	Throttle/pedal position sensor A circuit - accelerator pedal position (APP) sensor track 1 - erratic	• APP sensor track 1: short circuit to power • APP sensor track 1: short circuit to ground • APP sensor track 1: open circuit • APP sensor fault	Check the APP sensor and circuits. Refer to the electrical guides. Rectify as necessary. Install a new APP sensor if necessary. REFER to: Accelerator Pedal Position (APP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P012084	Throttle/pedal position sensor A circuit - accelerator pedal position (APP) sensor track 1 - signal below allowable range	• APP sensor track 1: short circuit to power • APP sensor track 1: short circuit to ground • APP sensor track 1: open circuit • APP sensor fault	
P012085	Throttle/pedal position sensor A circuit - accelerator pedal position (APP) sensor track 1 - signal above allowable range	• APP sensor track 1: short circuit to power • APP sensor track 1: short circuit to ground • APP sensor track 1: open circuit • APP sensor fault	
P01802F	Fuel temperature sensor A circuit - signal erratic	• Fuel temperature sensor circuit: short circuit to ground • Fuel temperature sensor circuit: short circuit to power • Fuel temperature sensor circuit: open circuit • Fuel temperature sensor fault	Check the fuel temperature sensor and circuits. Refer to the electrical guides. The fuel temperature sensor is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P018011	Fuel temperature sensor A circuit - circuit short to ground	• Fuel temperature sensor circuit: short circuit to ground • Fuel temperature sensor fault	
P018015	Fuel temperature sensor A circuit - circuit short to battery or open	• Fuel temperature sensor circuit: short circuit to power • Fuel temperature sensor circuit: open circuit • Fuel temperature sensor fault	
P019011	Fuel rail pressure sensor A circuit - circuit short to ground	• Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to

			the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P019015	Fuel rail pressure sensor A circuit - circuit short to battery or open	• Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	
P019164	Fuel rail pressure sensor A circuit range/performance - signal plausibility failure	• Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020011	Injector circuit - circuit short to ground	• Injector circuit: short circuit to ground • Injector fault	Check the injector and injector circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020012	Injector circuit - circuit short to battery	• Injector circuit: short circuit to power • Injector fault	
P020100	Cylinder 1 (injector 1) circuit / open	• Cylinder 1 injector circuit: open circuit • Cylinder 1 injector fault	Check the cylinder 1 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020200	Cylinder 2 (injector 4) circuit / open	• Cylinder 2 injector circuit: open circuit • Cylinder 2 injector fault	Check the cylinder 2 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020300	Cylinder 3 (injector 2) circuit / open	• Cylinder 3 injector circuit: open circuit • Cylinder 3 injector fault	Check the cylinder 3 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P020400	Cylinder 4 (injector 3) circuit / open	• Cylinder 4 injector circuit: open circuit • Cylinder 4 injector fault	Check the cylinder 4 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P022000	Accelerator pedal position (APP) sensor/switch B circuit	• APP sensor track 2: short circuit to power • APP sensor track 2: short circuit to ground • APP sensor track 2: open circuit • APP sensor fault	Check the APP sensor and circuits. Refer to the electrical guides. Rectify as necessary. Install a new APP sensor if necessary. REFER to: Accelerator Pedal Position (APP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02202F	Accelerator pedal position (APP) sensor/switch B circuit - signal erratic	• APP sensor track 2: short circuit to power • APP sensor track 2: short circuit to ground • APP sensor track 2: open circuit • APP sensor fault	
P023400	Turbocharger A over boost condition	• Turbocharger circuit fault • Turbocharger fault	Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger

		• Engine control module (ECM) fault	vanes etc. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P023521	Turbocharger boost sensor A circuit - signal amplitude less than minimum	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	Check the MAPT sensor and circuit. Refer to the electrical guides. Install a new MAPT sensor if necessary. REFER to: Manifold Absolute Pressure and Temperature (MAPT) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P023522	Turbocharger boost sensor A circuit - signal amplitude greater than maximum	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	
P02352F	Turbocharger boost sensor A circuit - signal erratic	• NOTE: The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault	
P026100	Cylinder 1 (injector 1) circuit low	• Cylinder 1 injector circuit: short circuit to ground • Cylinder 1 injector fault	Check the cylinder 1 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P026400	Cylinder 2 (injector 4) circuit low	• Cylinder 2 injector circuit: short circuit to ground • Cylinder 2 injector fault	Check the cylinder 2 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P026700	Cylinder 3 (injector 2) circuit low	• Cylinder 3 injector circuit: short circuit to ground • Cylinder 3 injector fault	Check the cylinder 3 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P027000	Cylinder 4 (injector 3) circuit low	• Cylinder 4 injector circuit: short circuit to ground • Cylinder 4 injector fault	Check the cylinder 4 injector and circuit. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P029900	Turbocharger A under boost condition	• Turbocharger circuit fault • Turbocharger fault • Engine control module (ECM) fault	Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger vanes etc. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

			Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P029C00	Cylinder 1 balance - (injector 1) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A000	Cylinder 2 balance - (injector 4) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A400	Cylinder 3 balance - (injector 2) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P02A800	Cylinder 4 balance - (injector 3) restricted	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P033529	Condition and fitment of the crankshaft position (CKP) sensor A circuit - signal invalid	• CKP sensor • CKP sensor circuit: short circuit to ground • CKP sensor circuit: short circuit to power • CKP sensor circuit: open circuit • CKP sensor fault • CKP sensor wheel fault	Check the CKP sensor and circuits. Refer to the electrical guides. Check the sensor and wheel for correct installation and condition. Rectify as necessary. Install a new CKP sensor if necessary. REFER to: Crankshaft Position (CKP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P033531	Condition and fitment of the crankshaft position (CKP) sensor A circuit - no signal	• CKP sensor • CKP sensor circuit: short circuit to ground • CKP sensor circuit: short circuit to power • CKP sensor circuit: open	

		circuit • CKP sensor fault • CKP sensor wheel fault	
P034023	Camshaft position (CMP) sensor A circuit (bank 1 or single sensor) - signal stuck low	• CMP sensor circuit: short circuit to ground • CMP sensor circuit: short circuit to power • CMP sensor circuit: open circuit • CMP sensor fault	Check the CMP sensor and circuits. Refer to the electrical guides. Install a new CMP sensor if necessary. REFER to: Camshaft Position (CMP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P034024	Camshaft position sensor (CMP) A circuit (bank 1 or single sensor) - signal stuck high	• CMP sensor circuit: short circuit to ground • CMP sensor circuit: short circuit to power • CMP sensor circuit: open circuit • CMP sensor fault	
P037D29	Glow plug relay sensor circuit - signal invalid	• Glow plug short circuit to ground • Relay circuit to relay • Relay circuit from relay • Glow plug relay fault	Check the relay and circuits. Refer to the electrical guides. Activate the relay and check for an audible "click". Rectify as necessary. Clear the DTCs and test for normal operation.
P038011	Glow plug/heater circuit A - circuit short to ground	• Glow plug relay control circuit: short circuit to ground • Glow plug relay fault	Check the relay and circuits. Refer to the electrical guides. Activate the relay and check for an audible "click". Rectify as necessary. Clear the DTCs and test for normal operation.
P038015	Glow plug/heater circuit A - circuit short to battery or open	• Glow plug relay control circuit: short circuit to power • Glow plug relay control circuit: open circuit • Glow plug relay fault	
P04031A	Exhaust gas recirculation (EGR) control circuit - circuit resistance below threshold	• EGR control valve actuator circuit: short circuit to ground • EGR control valve actuator circuit: short circuit to power • EGR control valve actuator circuit: open circuit • EGR control valve fault	Check the EGR control valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P04031B	Exhaust gas recirculation (EGR) control circuit - circuit resistance above threshold	• EGR control valve actuator circuit: short circuit to ground • EGR control valve actuator circuit: short circuit to power • EGR control valve actuator circuit: open circuit • EGR control valve fault	
P040311	Exhaust gas recirculation (EGR) control circuit -	• EGR control valve actuator circuit	

	circuit short to ground	short circuit to ground • EGR control valve fault	
P040312	Exhaust gas recirculation (EGR) control circuit - circuit short to battery	• EGR control valve actuator circuit: short circuit to power • EGR control valve fault	
P040472	Exhaust gas recirculation (EGR) control circuit range/performance - actuator stuck open	• EGR control valve actuator circuit fault • EGR control valve fault	Check the EGR control valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P040473	Exhaust gas recirculation (EGR) control circuit range/performance - actuator stuck closed	• EGR control valve actuator circuit fault • EGR control valve fault	
P048000	Fan 1 control circuit on/off	• Cooling fan control circuit: short circuit to ground • Cooling fan control circuit: short circuit to power • Cooling fan control circuit: open circuit • Cooling fan fault	Check the cooling fan and circuits. Refer to the electrical guides. Install a new cooling fan if necessary. REFER to: Cooling Fan (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P05032F	Vehicle speed sensor (VSS) A intermittent/erratic/high - signal erratic	• VSS A circuit: short circuit to ground • VSS A circuit: short circuit to power • VSS A circuit: open circuit • VSS A fault	Check for instrument cluster related DTCs. Rectify as necessary. Check the VSS sensor and circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P050337	Vehicle speed sensor (VSS) A intermittent/erratic/high - signal frequency too high	• VSS A circuit: short circuit to ground • VSS A circuit: short circuit to power • VSS A circuit: open circuit • VSS A fault	Check for instrument cluster related DTCs. Rectify as necessary. Check the VSS sensor and circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P052015	Engine oil pressure (EOP) sensor switch circuit - circuit short to battery or open	• EOP sensor/switch circuit: short circuit to power • EOP sensor/switch circuit: open circuit • EOP sensor/switch fault	Check the EOP sensor/switch and circuits. Refer to the electrical guides. Install a new EOP sensor if necessary. REFER to: Engine Oil Pressure (EOP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P056200	System voltage low	• Battery condition/state of charge • Charging system fault	Check the battery condition and state of charge. Check the charging system. Install a new generator if necessary. REFER to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P056300	System voltage high	• Battery condition/state of charge • Charging system fault	
P057100	Brake switch A circuit	• Brake switch circuit: short circuit to power • Brake switch circuit: short	Check the brake switch and circuits. Refer to the

		• circuit to ground • Brake switch circuit: open circuit • Brake switch fault	electrical guides. Install a new brake switch if necessary. Clear the DTCs and test for normal operation.
P060200	Engine control module (ECM) programming error	• Fuel programming error	Reprogramme the module using the approved diagnostic system. Refer to the warranty policy and procedures manual if a module is suspect.
P060543	Internal control module read only memory (ROM) error -special memory failure	• Engine control module (ECM) programming error	Reprogramme the module using the approved diagnostic system. Refer to the warranty policy and procedures manual if a module is suspect.
P060554	Internal control module read only memory (ROM) error - missing calibration	• Engine control module (ECM) programming error	
P060616	Engine control module (ECM) processor - circuit voltage below threshold	• ECM fault	Refer to the warranty policy and procedures manual if the ECM is suspect.
P060647	Engine control module (ECM) processor - watchdog failure	• ECM fault	
P060649	Engine control module (ECM) processor- internal electronic failure	• ECM fault	
P060696	Engine control module (ECM) processor - component internal failure	• ECM fault	
P061000	Control module vehicle options error	• Tyre size is incompatible with the central car configuration	Check tyre sizes are of the correct specification. Rectify as necessary. Check correct central car configuration software is installed. Reprogramme the module as necessary.
P061512	Starter relay circuit - circuit short to battery	• Starter relay circuit: short circuit to power	Check the starter relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P061514	Starter relay circuit - circuit short to ground or open	• Starter relay circuit: short circuit to ground • Starter relay circuit: open circuit	
P062211	Generator field terminal circuit - circuit short to ground	• Generator field terminal circuit: short circuit to ground • Generator fault	Check the charging voltage. Check the charging system circuits. Refer to the electrical guides. Install a new generator if necessary REFER to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P062215	Generator field terminal circuit - circuit short to battery or open	• Generator field terminal circuit: short circuit to power • Generator field terminal circuit: open circuit • Generator fault	
P062300	Generator lamp control circuit	• Check generator belt is not broken, excessively worn or slipping when engine running • Generator lamp control circuit fault • Generator fault	Check the charging voltage. Install a new accessory drive belt if necessary. REFER to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Check the charging system circuits. Check the generator lamp control circuit. Refer to the electrical guides. Install a new generator if necessary. REFER to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P062B16	Internal control module fuel injector control performance - circuit voltage below threshold	• Engine control module (ECM) fault	Refer to the warranty policy and procedures manual if the ECM is suspect.
P062B17	Internal control module fuel injector control performance - circuit voltage above threshold	• Engine control module (ECM) fault	

P064200	Sensor reference voltage A circuit low (internal to engine control module (ECM))	• ECM circuits: short circuit to ground • ECM circuits: open circuit • ECM fault	Check the ECM power supply and relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTC. Cycle the ignition and retest. If the DTC resets suspect the ECM. Refer to the warranty policy and procedures manual if a module is suspect.
P064300	Sensor reference voltage A circuit low (internal to engine control module (ECM))	• ECM circuits: short circuit to power • ECM fault	Check the ECM power supply and relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTC. Cycle the ignition and retest. If the DTC resets suspect the ECM. Refer to the warranty policy and procedures manual if a module is suspect.
P064523	Air conditioning (A/C) clutch relay control circuit - signal stuck low	• A/C clutch relay control circuit: short circuit to ground • A/C clutch relay control circuit: open circuit • A/C clutch relay fault	Check A/C clutch relay and circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P064524	Air conditioning (A/C) clutch relay control circuit - signal stuck high	• A/C clutch relay control circuit: short circuit to power • A/C clutch relay control circuit: open circuit • A/C clutch relay fault	
P065116	Sensor reference voltage B circuit / open - circuit voltage below threshold	• Engine control module (ECM) fault	Refer to the warranty policy and procedures manual if the ECM is suspect.
P065117	Sensor reference voltage B circuit / open -circuit voltage above threshold	• Engine control module (ECM) fault	
P06662F	Engine control module (ECM) internal temperature sensor circuit -signal erratic	• ECM fault	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P066621	Engine control module (ECM) internal temperature sensor circuit - signal amplitude less than minimum	• ECM fault	
P066622	Engine control module (ECM) internal temperature sensor circuit - signal amplitude greater than maximum	• ECM fault	
P068A00	Engine control module (ECM) power relay de-energized - too early	• ECM power relay: open circuit • ECM power relay: short circuit to ground	Check the ECM power relay power supply and relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTC and test for normal operation.
P068B00	Engine control module (ECM) power relay de-energized - too late	• ECM power relay: open circuit • ECM power relay: short circuit to ground	
P068516	Engine control module (ECM) power relay control circuit/open - circuit voltage below threshold	• ECM fault	Refer to the warranty policy and procedures manual if the ECM is suspect.
P068596	Engine control module (ECM) power relay control circuit/open - component internal failure	• ECM fault	
P070464	Clutch switch input circuit - signal plausibility failure	• Clutch switch circuit: short circuit to ground • Clutch switch fault	Check the clutch switch and circuits. Refer to the electrical guides. Clear the DTCs and test for normal operation.
P110200	Mass air flow (MAF) sensor in range but lower than expected	• Intake air path fault • MAF sensor	

		circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor circuit: open circuit • MAF sensor fault	Check the intake air system for leaks, restrictions, etc. Check the MAF sensor and circuits. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P110300	Mass air flow (MAF) sensor in range but higher than expected	• Intake air path fault • MAF sensor circuit: open circuit • MAF sensor circuit: short circuit to ground • MAF sensor circuit: short circuit to power • MAF sensor fault	Check the intake air system for leaks, restrictions, etc. Check the MAF sensor and circuits. Refer to the electrical guides. Install a new MAF sensor if necessary. REFER to: Mass Air Flow (MAF) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P115A00	Low fuel level - forced limited power	• Low fuel • Fuel level sensor circuit: short circuit to ground • Fuel level sensor circuit: open circuit • Fuel level sensor fault	Check that there is sufficient fuel in the tank. Check the fuel level sensor and circuits. Refer to the electrical guides. Install a new fuel level sensor if necessary. REFER to: Fuel Level Sender (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P115B00	Low fuel level - forced engine shutdown	• Low fuel • Fuel level sensor circuit: short circuit to ground • Fuel level sensor circuit: open circuit • Fuel level sensor fault	
P116900	Fuel rail pressure sensor in range but high	• Fuel rail pressure sensor circuit: short circuit to ground • Fuel rail pressure sensor circuit: short circuit to power • Fuel rail pressure sensor circuit: open circuit • Fuel rail pressure sensor fault	Check the fuel rail pressure sensor and circuits. Refer to the electrical guides. The fuel rail pressure sensor is not serviceable separately. Install a new fuel rail if necessary. REFER to: Fuel Rail (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P121C00	Cylinder balance - injector leaking	• Injector leak • Cylinder compression low - Blow-by past the injector - Blow-by past the glow plug - Mechanical fault, valve, piston/ring, etc. • Injector fault	Check the injector and surrounding area for evidence of fuel leakage. Disconnect the injector and check for evidence of fuel leakage in the connector. Rectify as necessary. Clear the DTCs. Reconnect the injector and start the engine. Allow to warm up and allow to idle (cylinder balance diagnosis is now active). If the DTC resets, check for blow-by etc. and rectify as necessary. Clear the DTCs and recheck. Carry out a compression test only if the DTC resets. If the above tests are all within range, install a new injector. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
P12402F	Sensor power supply - signal erratic (internal to engine control module (ECM))	• ECM circuits: short circuit to power • ECM circuits: short circuit to ground • ECM circuits: open circuit • ECM fault	Check the ECM power supply and relay circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTC. Cycle the ignition and retest. If the DTC resets suspect the ECM. Refer to the warranty policy and procedures manual if a module is suspect.
P124633	Generator load input - signal low time greater than maximum	• Engine control module (ECM) generator circuit:	

		short circuit to ground • ECM - generator circuit: short circuit to power • ECM - generator circuit: open circuit • Generator fault	
P124635	Generator load input - signal high time greater than maximum	• Engine control module (ECM) - generator circuit: short circuit to ground • ECM - generator circuit: short circuit to power • ECM - generator circuit: open circuit • Generator fault	Check the ECM - generator circuits. Refer to the electrical guides. Rectify as necessary. Install a new generator if necessary. REFER to: Generator (414-02 Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P124636	Generator load input - signal frequency too low	• Engine control module (ECM) - generator circuit: short circuit to ground • ECM - generator circuit: short circuit to power • ECM - generator circuit: open circuit • Generator fault	
P124637	Generator load input - signal frequency too high	• Engine control module (ECM) - generator circuit: short circuit to ground • ECM - generator circuit: short circuit to power • ECM - generator circuit: open circuit • Generator fault	
P129300	Injector high side open - bank 1 - cylinders 1 or 4 (injectors 1 or 3)	• Fuel injector circuit (high side): open circuit • Fuel injector circuit (high side): short circuit to ground • Fuel injector circuit (high side): short circuit to power • Fuel injector fault	Check the fuel injectors and circuits. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P129400	Injector high side open - bank 2 - cylinders 2 or 3 (injectors 4 or 2)	• Fuel injector circuit (high side): open circuit • Fuel injector circuit (high side): short circuit to ground • Fuel injector circuit (high side): short circuit to power • Fuel injector fault	Check the fuel injectors and circuits. Refer to the electrical guides. Install a new injector if necessary. REFER to: Fuel Injector (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P14022F	Exhaust gas recirculation (EGR) control valve metering orifice restricted - signal erratic	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve control circuit: short	

		• circuit to power • EGR valve fault	Check the EGR valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P140216	Exhaust gas recirculation (EGR) control valve - circuit voltage below threshold	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve fault	
P140217	Exhaust gas recirculation (EGR) control valve - circuit voltage above threshold	• EGR valve control circuit: short circuit to power • EGR valve fault	
P140977	Exhaust gas recirculation (EGR) control valve vacuum regulator solenoid circuit - commanded position not reachable	• EGR valve control circuit: open circuit • EGR valve control circuit: short circuit to ground • EGR valve control circuit: short circuit to power • EGR valve fault	Check the EGR valve actuator and circuits. Refer to the electrical guides. Install a new EGR valve if necessary. REFER to: Exhaust Gas Recirculation (EGR) Valve (303-08 Engine Emission Control - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P164387	Controller area network (CAN) link engine control module/transmission control module circuit/network - missing CAN signal high / low switch.	• Transmission high - low switch circuit: short circuit to power • Transmission high - low switch circuit: short circuit to ground • Transmission high - low switch circuit: open circuit • Transmission high - low switch fault • Controller area network (CAN) circuit: open circuit • CAN circuit: short circuit to ground • CAN circuit: short circuit to power	Check the transmission high/low switch and circuits. Refer to the electrical guides. Rectify as necessary. Install a new transmission high - low switch if necessary. REFER to: Transfer Case Low Range Indicator Switch (308-07B Four-Wheel Drive Systems, Removal and Installation). Check the CAN circuits. Refer to the electrical guides. Rectify as necessary.
P167B00	Fuel injector learning not done	• Pilot correction learning procedure has not been completed • Engine control module (ECM) fault	Run pilot correction learning function in line with service procedures. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if the ECM is suspect.
P167B41	Fuel injector learning not done - general checksum failure	• Pilot correction learning procedure corrupted • Engine control module (ECM) fault	
P193512	Brake switch sensor signal - circuit short to battery	• Brake switch sensor signal: short circuit to power • Brake switch sensor fault	Check the brake switch and circuits. Refer to the electrical guides. Clear the DTCs and test for normal operation.
P193514	Brake switch sensor signal - circuit short to ground or open	• Brake switch sensor signal: short circuit to ground • Brake switch sensor signal: open circuit • Brake switch sensor fault	
P213564	Throttle/pedal position	• APP sensor	

	sensor/switch A / B voltage correlation - accelerator pedal position (APP) sensor track 1 voltage does not match accelerator pedal position (APP) sensor track 2 - signal plausibility failure	circuits: short circuit to power • APP sensor circuits: short circuit to ground • APP sensor circuits: open circuit • APP sensor fault	Check APP sensor and circuits. Refer to the electrical guides. Rectify as necessary. Install a new APP sensor if necessary. REFER to: Accelerator Pedal Position (APP) Sensor (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P214716	Fuel injector group A supply voltage circuit low - injector boost voltage too low	• Engine control module (ECM) fault	Clear the DTC. Start the engine and retest. Refer to the warranty policy and procedures manual if the ECM is suspect.
P214817	Fuel injector group A supply voltage circuit high - injector boost voltage too high	• Engine control module (ECM) fault	Clear the DTC. Start the engine and retest. Refer to the warranty policy and procedures manual if the ECM is suspect.
P215B64	Vehicle speed - output shaft speed (OSS) (vehicle speed sensor (VSS) correlation - signal plausibility failure	• VSS A circuit: short circuit to ground • VSS A circuit: short circuit to power • VSS A circuit: open circuit • VSS A fault	Check for instrument cluster related DTCs. Rectify as necessary. Check the VSS sensor and circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
P22262F	Barometric pressure circuit - signal erratic	• NOTE: Barometric pressure sensor is part of the engine control module (ECM) • Barometric pressure circuit: short circuit to power • Barometric pressure circuit: short circuit to ground • Barometric pressure circuit: open circuit	Refer to the warranty policy and procedures manual, if the ECM is suspect.
P222616	Barometric pressure circuit - circuit voltage below threshold	• NOTE: Barometric pressure sensor is part of the engine control module (ECM) • Barometric pressure circuit: short circuit to ground • Barometric pressure circuit: open circuit	
P222617	Barometric pressure circuit - circuit voltage above threshold	• NOTE: Barometric pressure sensor is part of the engine control module (ECM) • Barometric pressure circuit: short circuit to power	
P256234	Turbocharger boost control position sensor A circuit - signal high time less than minimum	• Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256235	Turbocharger boost control position sensor A circuit - signal high time	• Turbocharger boost control position sensor A	

	greater than maximum	circuit: short circuit to power • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256236	Turbocharger boost control position sensor A circuit - signal frequency too low	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	Check turbocharger sensor and circuit. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P256237	Turbocharger boost control position sensor A circuit - signal frequency too high	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P25632F	Turbocharger boost control position sensor A circuit range/performance - signal erratic	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	Check turbocharger sensor and circuit. Refer to the electrical guides. Install a new turbocharger if necessary. REFER to: Turbocharger (303-04B Fuel Charging and Controls - Turbocharger - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P256372	Turbocharger boost control position sensor A circuit range/performance - actuator stuck open	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P256373	Turbocharger boost control position sensor A circuit range/performance - actuator stuck closed	• Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger	

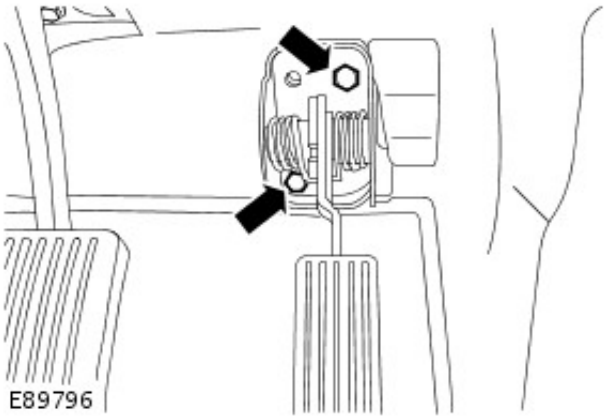
		• boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault	
P263507	Fuel pump A low flow / performance	Fuel supply pump insufficient flow	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the fuel suction control valve and circuits. Refer to the electrical guides. The fuel suction control valve is not serviceable separately. Install a new fuel injection pump if necessary. REFER to: Fuel Injection Pump (303-04A Fuel Charging and Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). Clear the DTCs and test for normal operation.
P268B00	High-pressure fuel pump calibration not learned/programmed	Pump learning procedure not run	Run pump learning procedure
P268C00	Cylinder 1 (injector 1) data incompatible	• Cylinder 1 (injector 1) classification code invalid	Re-enter the injector codes using the approved diagnostic system. Clear the DTCs, test for normal operation.
P268D00	Cylinder 3 (injector 2) data incompatible	• Cylinder 3 (injector 2) classification code invalid	
P268E00	Cylinder 4 (injector 3) data incompatible	• Cylinder 4 (injector 3) classification code invalid	
P268F00	Cylinder 2 (injector 4) data incompatible	• Cylinder 2 (injector 4) classification code invalid	
U000188	High speed controller area network (CAN) communication bus - bus off	• CAN circuit: open circuit • CAN circuit: short circuit to each other • CAN control module failure	Carry out a complete vehicle read for DTCs indicating a CAN circuit or module fault. Rectify as necessary. Refer to the warranty policy and procedures manual if a module is suspect.
U015500	Lost communication with instrument cluster	• Signal from instrument cluster timed out	Check for other controller area network (CAN) DTCs or apparently unrelated customer complaints. Carry out a complete vehicle DTC read. Check the CAN circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
U030000	Internal control module software incompatibility	• Incorrect hardware/software level • Controller area network (CAN) circuit between the engine control module (ECM) and the instrument cluster: open circuit	Check that the modules are correct for the vehicle and that the correct level of software is installed. Reconfigure the CAN system. Check the CAN circuits. Refer to the electrical guides. Rectify as necessary.
U210087	Initial configuration not complete - missing message	• Controller area network (CAN) circuit fault • Initial central configuration has never been sent	Check for other controller area network (CAN) DTCs or apparently unrelated customer complaints. Carry out a complete vehicle DTC read. Check the CAN circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation. Check correct central car configuration software is installed. Reprogramme the module as necessary.
U210100	Control module configuration incompatible	• Central car configuration parameter missing or corrupted	Check correct central car configuration software is installed. Reprogramme the module as necessary.

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Accelerator Pedal Position (APP) Sensor

Removal and Installation

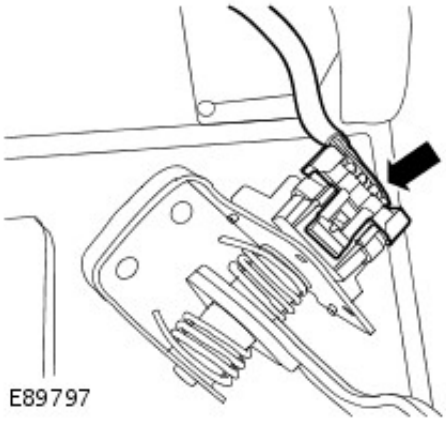
Removal

• NOTE: The accelerator pedal position (APP) sensor is an integral part of the accelerator pedal assembly and must not be dismantled.



1. With assistance, release the accelerator pedal position (APP) sensor from the bulkhead.

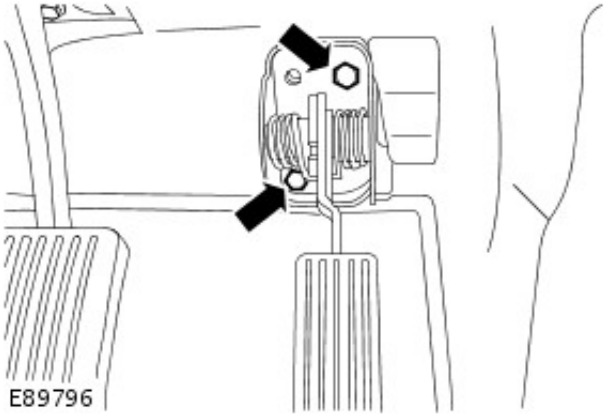
- Remove the 2 bolts.



2. Remove the APP sensor.

- Disconnect the APP sensor electrical connector.

Installation



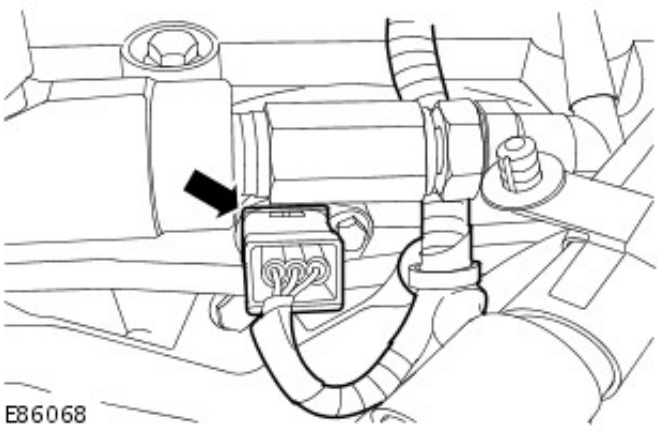
1. To install, reverse the removal procedure.

- Tighten to 25 Nm (18 lb.ft).

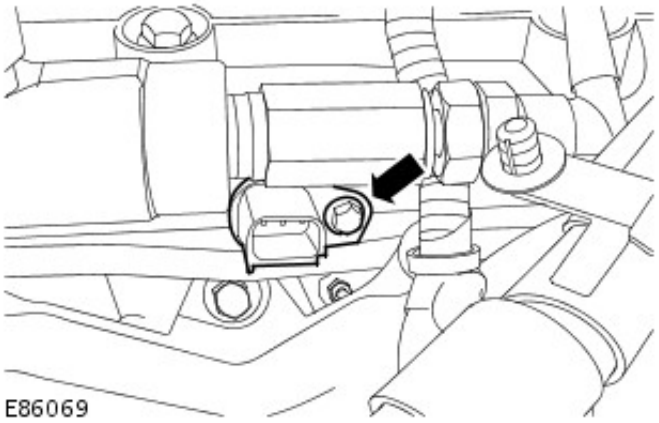
Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Camshaft Position (CMP) Sensor

Removal and Installation

Removal



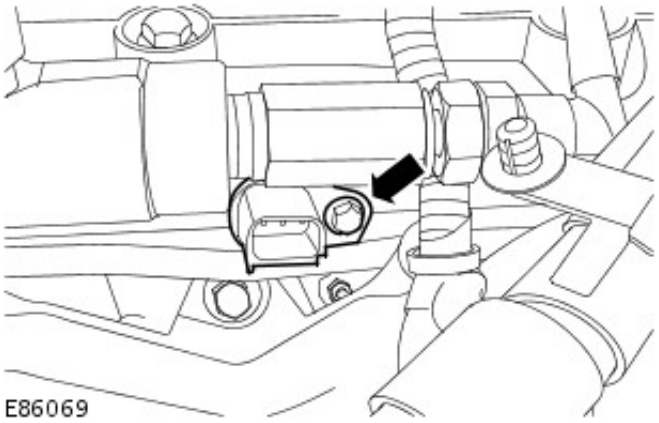
1. Disconnect the camshaft position (CMP) sensor electrical connector.



2. Remove the CMP sensor.

- Remove the bolt.
- Remove and discard the O-ring seal.

Installation



1. NOTE: Install a new O-ring seal.

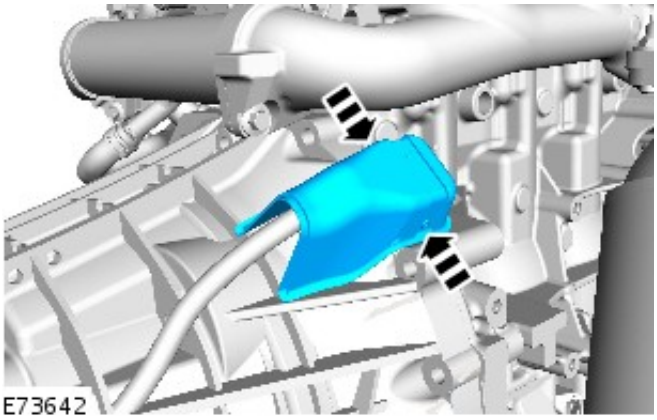
To install, reverse the removal procedure.

- Tighten to 9 Nm (7 lb.ft).

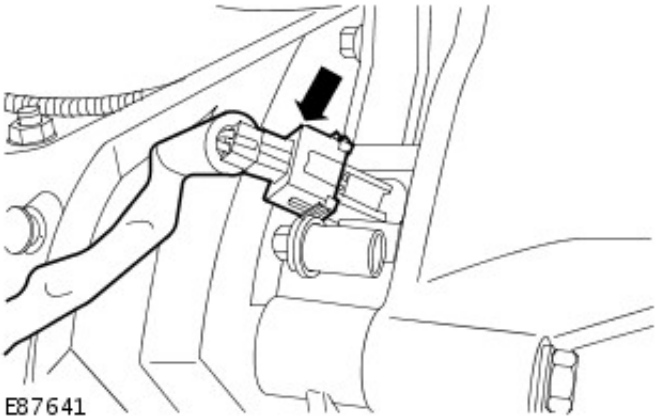
Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Crankshaft Position (CKP) Sensor

Removal and Installation

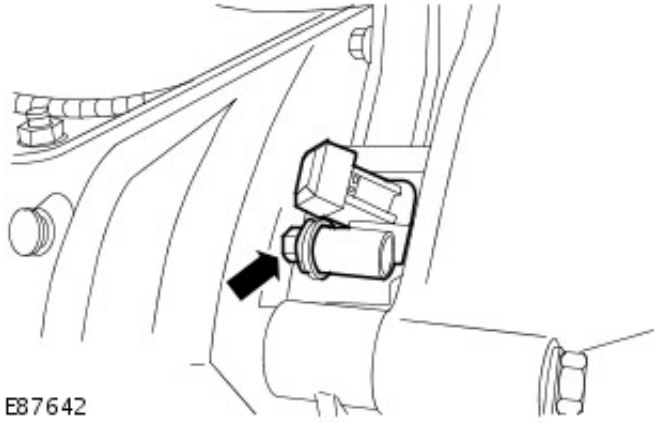
Removal



1. Remove the cover.



2. Disconnect the crankshaft position (CKP) sensor electrical connector.

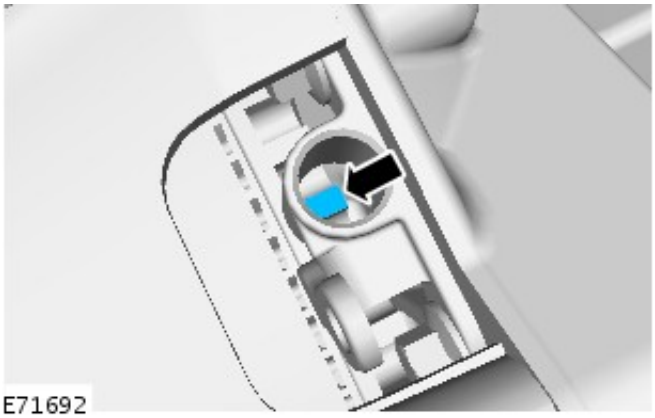


3. Remove and discard the CKP sensor.

- Remove the bolt.

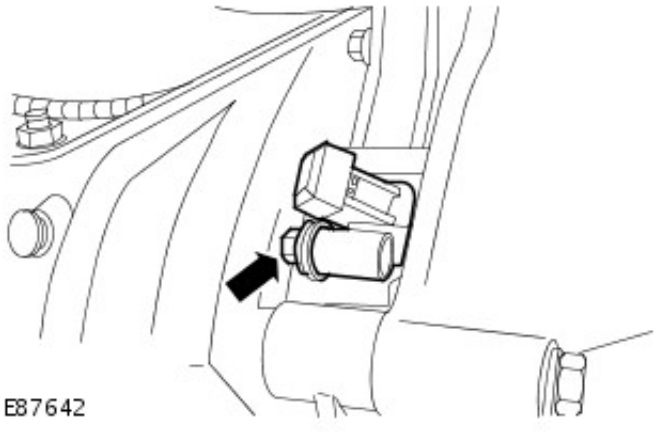
Installation

1. NOTE: Only turn the engine in the normal direction of



rotation.

Turn the engine until a flywheel trigger tooth is visible through the CKP sensor housing.



2. CAUTION: The CKP sensor tip must rest on a flywheel trigger tooth. Incorrect installation may result in the CKP sensor being damaged.

• NOTE: Make sure that the CKP sensor housing is clean and free from foreign material.

Install the CKP sensor.

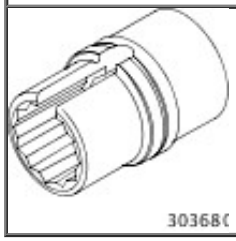
- Tighten to 7 Nm.

3. Connect the CKP sensor electrical connector.

4. Install the cover.

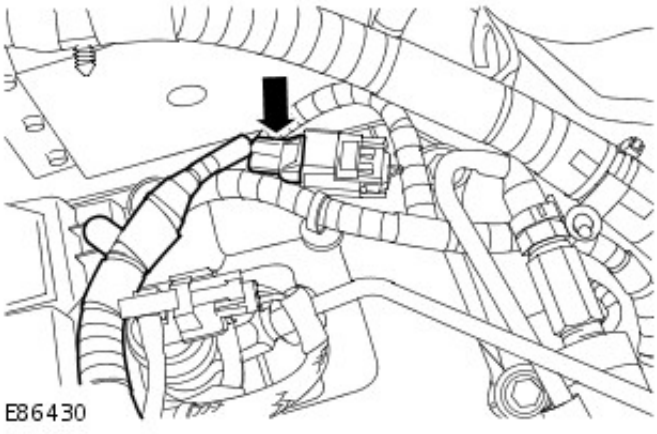
Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Cylinder Head Temperature (CHT) Sensor

Removal and Installation

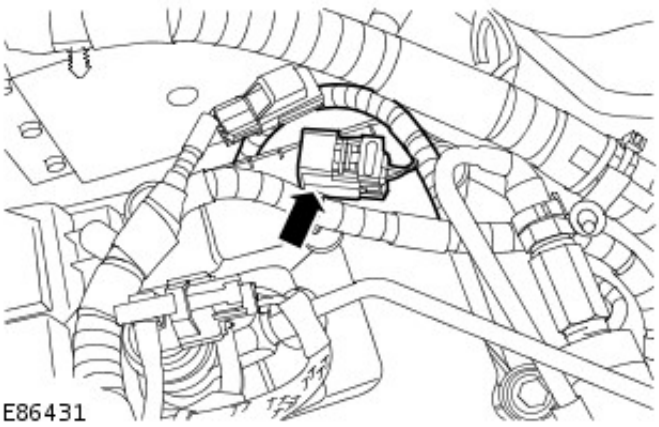
Special Tool(s)	
	Socket, CHT Sensor 303-680

Removal

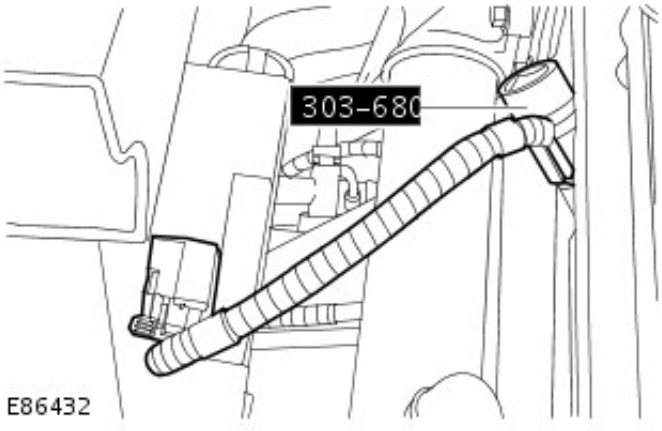
1. Remove the engine cover.
   For additional information, refer to: Engine Cover (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect the cylinder head temperature (CHT) sensor.



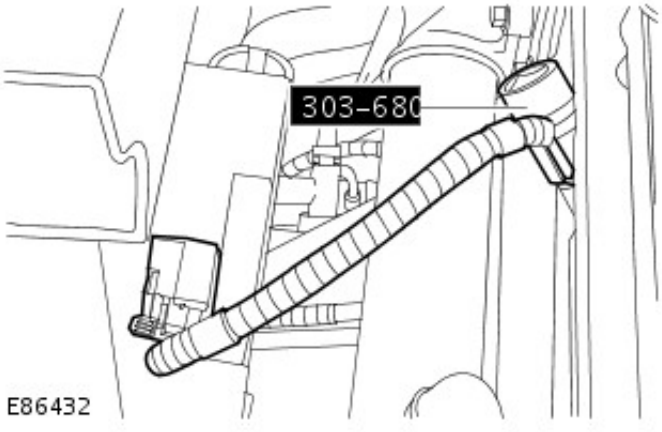
3. Release the CHT sensor wiring harness.



4. Using the special tool, remove the CHT sensor.



Installation



1. To install, reverse the removal procedure.

- Tighten to 10 Nm (7 lb.ft).

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Control Module (ECM)

Removal and Installation

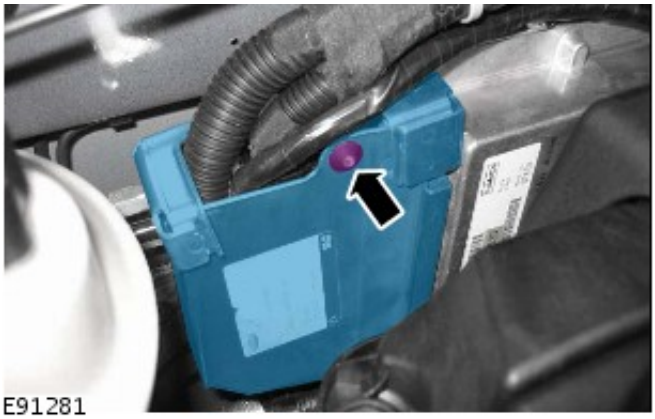
Removal

CAUTION: When a new engine control module (ECM) is installed, the Land Rover approved diagnostic system must be connected to the vehicle and the ECM renewal procedure must be followed. This will allow the vehicle configuration to be uploaded into the new ECM.

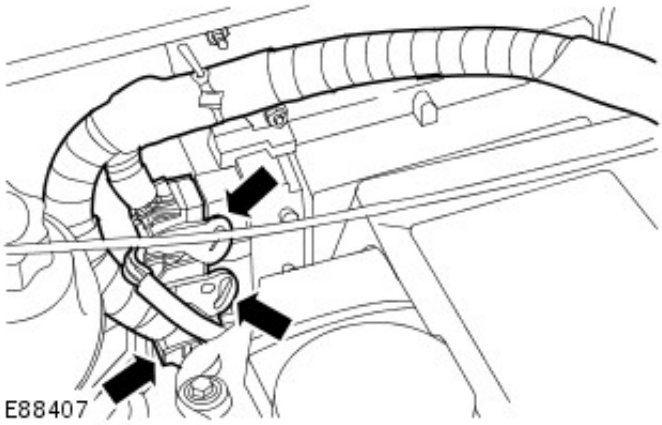
1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the engine control module (ECM) security bracket.

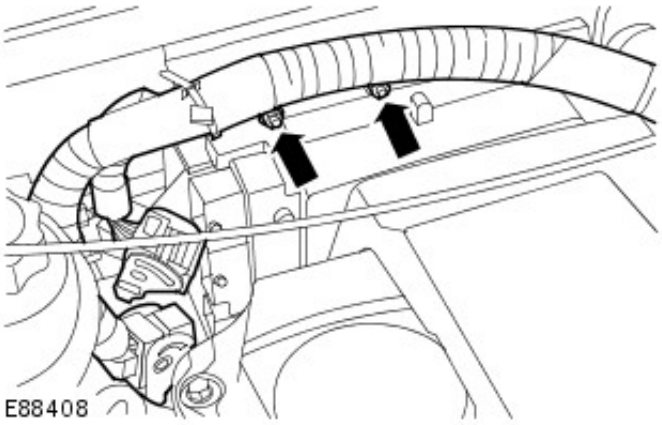
- Remove the bolt.



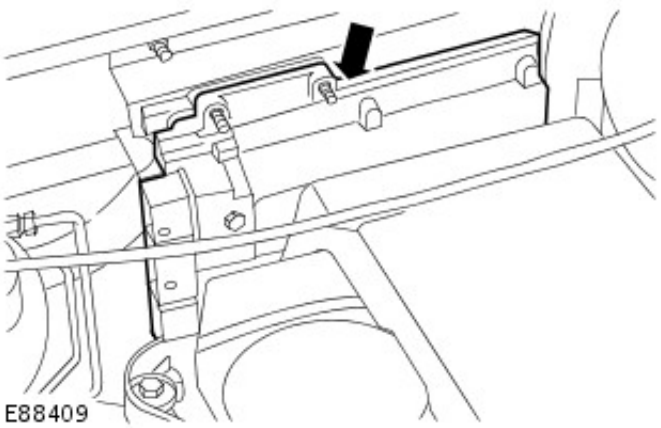
3. Disconnect the 3 electrical connectors.



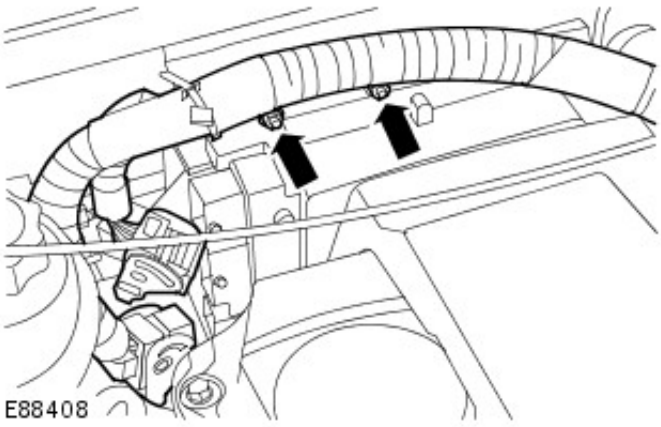
4. Remove the 2 ECM nuts.



5. Remove the ECM.



Installation



1. To install, reverse the removal procedure.

- Tighten to 10 Nm (7 lb.ft).

2. CAUTION: Make sure that the fuel pump replacement and pilot correction learn are carried out following the download.

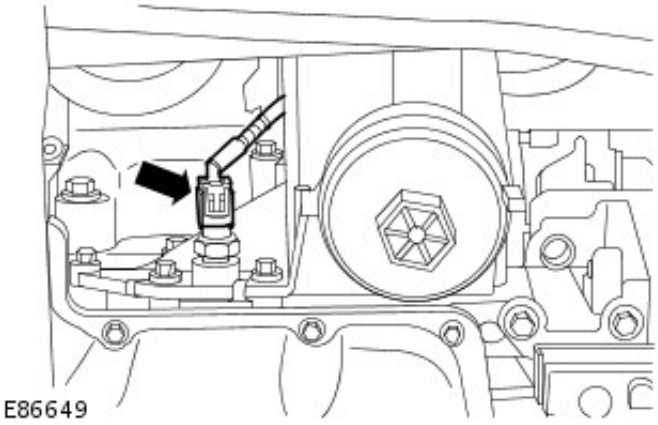
Using the Land Rover approved diagnostic system, configure the new ECM.

Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Engine Oil Pressure (EOP) Sensor

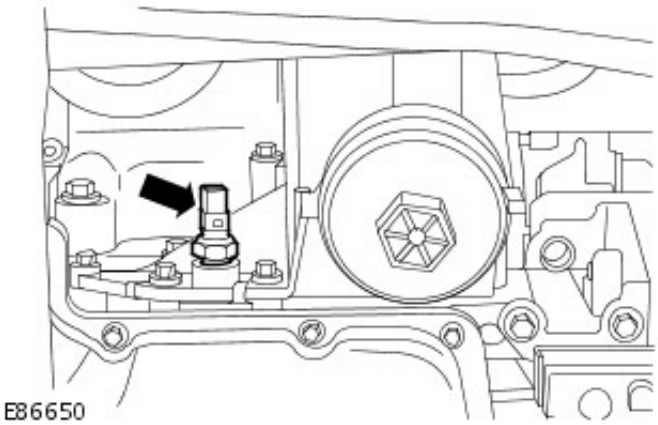
Removal and Installation

Removal

1. Raise and support the vehicle.
   For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).
2. Disconnect the engine oil pressure (EOP) sensor electrical connector


E86649

3. Remove the EOP sensor.


E86650

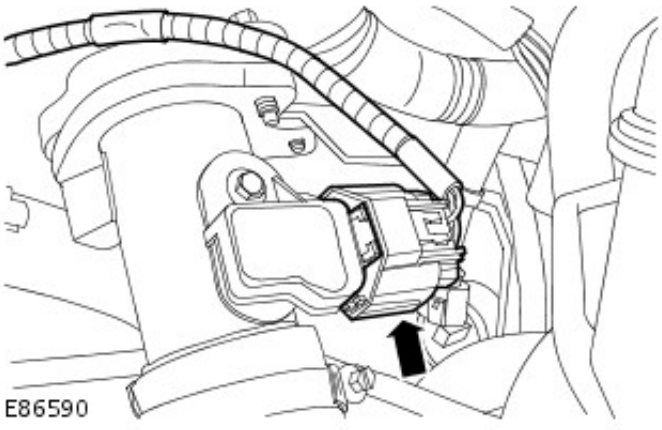
Installation

1. Install the EOP sensor.
   - Tighten to 15 Nm (11 lb.ft).
2. Connect the EOP sensor electrical connector.

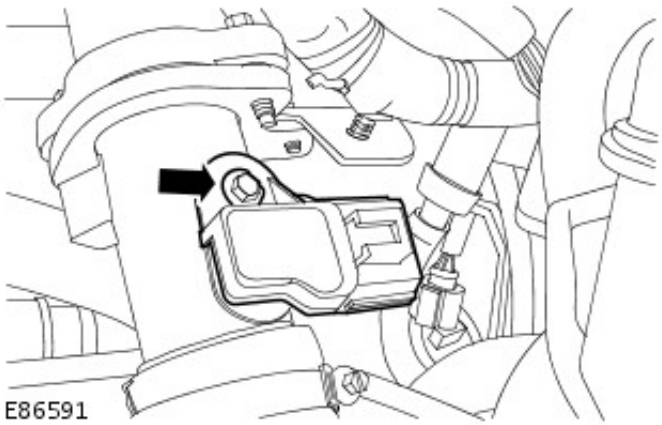
Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Manifold Absolute Pressure and Temperature (MAPT) Sensor

Removal and Installation

Removal



1. Disconnect the manifold absolute pressure and temperature (MAPT) sensor electrical connector.

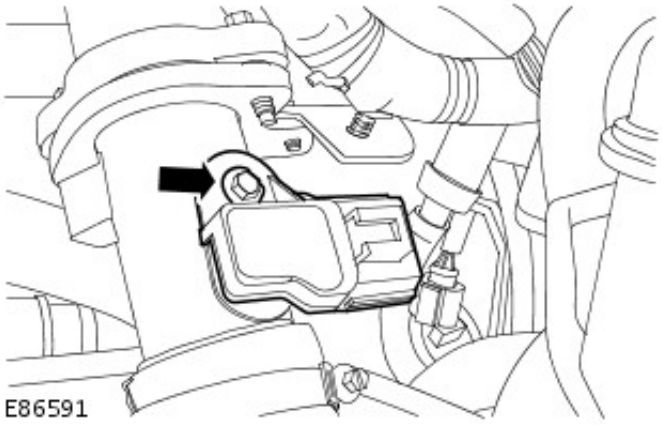


2. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the MAPT sensor.

- Remove the bolt.
- Remove and discard the O-ring seal.

Installation



1. NOTE: Remove and discard the blanking caps.

• NOTE: Install a new O-ring seal.

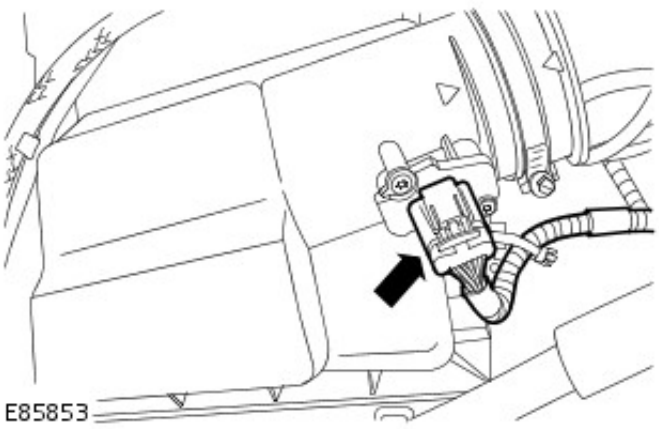
To install, reverse the removal procedure.

- Tighten to 3 Nm (2 lb.ft).

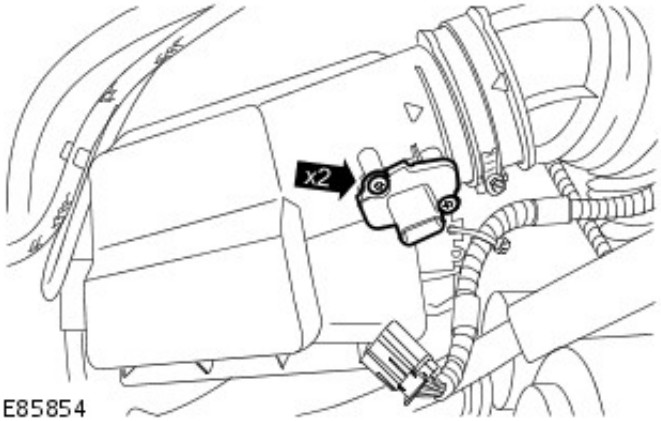
Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Mass Air Flow (MAF) Sensor

Removal and Installation

Removal



1. Disconnect the mass air flow (MAF) sensor electrical connector.



2. Remove the MAF sensor.

- Remove the 2 screws.
- Remove and discard the O-ring seal.

Installation

1. NOTE: Install a new O-ring seal.

To install, reverse the removal procedure.

Manual Transmission/Transaxle and Clutch - General Information - Clutch System Bleeding

General Procedures

WARNING: Brake fluid contains polyglycol ethers and polyglycols. Avoid contact with the eyes. Wash hands thoroughly after handling. If brake fluid contacts the eyes, flush the eyes for 15 minutes with cold water. Get medical attention immediately if irritation persists. If taken internally, drink water and induce vomiting. Get medical attention immediately. Failure to follow these instructions may result in personal injury.

- CAUTIONS:

Make sure the brake fluid in the clutch system reservoir is maintained between the minimum and maximum levels throughout the bleed procedure using new brake fluid.

If brake fluid comes into contact with the paintwork, it should be washed down immediately with cold water.

1. NOTE: Make sure of absolute cleanliness when filling brake fluid.

- NOTE: Do not re-use brake fluid.

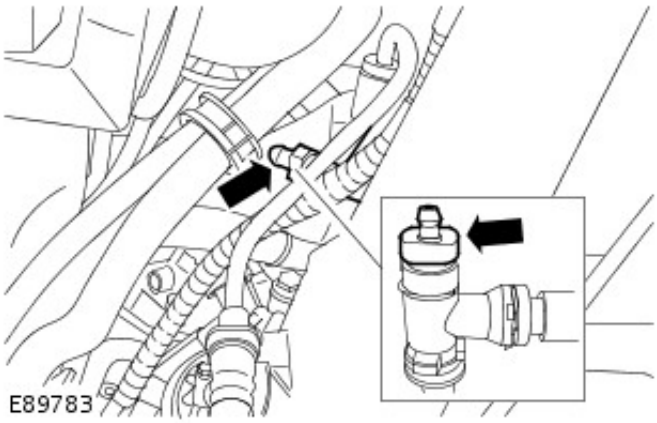
As necessary, fill the clutch system reservoir with brake fluid.

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

3. Remove the bleed nipple cover.

4. Connect a clear bleed tube to the bleed nipple and submerge the free end into a clear container of brake fluid.



5. Bleed the clutch system.

- Loosen the bleed nipple by 2 turns.
- Apply steady pressure to the clutch pedal, depressing it through its full stroke.
- Hold the pedal down and tighten the bleed nipple.
- Return the pedal to return its normal position.

6. Repeat the procedure until a flow of clean, air-free brake fluid is purged into the container.

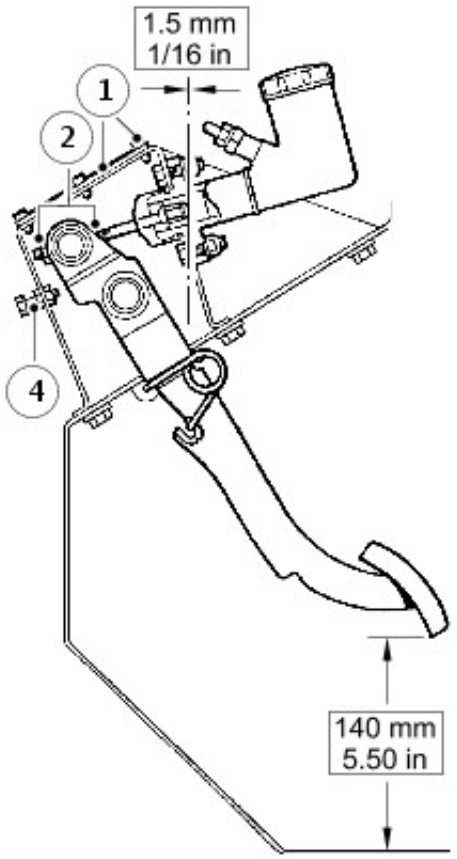
7. NOTE: Do not re-use brake fluid.

Check and top up the clutch system reservoir.

8. Remove the stands and lower the vehicle.

Manual Transmission/Transaxle and Clutch - General Information - Clutch Pedal Freeplay Adjustment

General Procedures



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1. Remove 6 screws and detach pedal box top cover and gasket.

2. Slacken both locknuts on master cylinder push-rod.

3. Check distance from lower edge of clutch pedal to floor. Correct measurement is 140 mm (5.50 in) without floor mat.

4. Adjust pedal stop as necessary to obtain correct setting.

5. Adjust master cylinder push rod to obtain approximately 1.5 mm (1/16 in) free play between push-rod and master cylinder piston.

6. Tighten push rod locknuts.

7. Check operation of clutch pedal and ensure that there is a minimum of 6 mm (0.25 in) of free play before pressure is felt. if necessary, readjust master cylinder push-rod.

8. Fit top cover and gasket to pedal bracket.

9. On RH drive vehicles, refit air cleaner.

Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Clutch pressure plate bolts (new bolts must be installed)	29	21

Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - ClutchVehicles With: 6-Speed Manual Transmission - MT82

Description and Operation

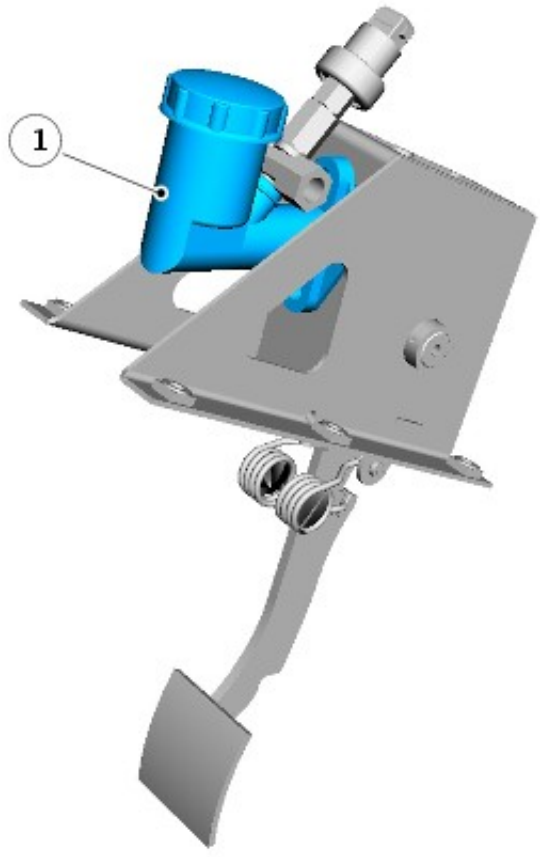
OVERVIEW

The clutch system is based on the established principle of a single driven plate and diaphragm spring clutch cover assembly hydraulically actuated from the clutch pedal. Depressing the clutch pedal transfers hydraulic fluid through the master cylinder, pipe work, and concentric slave cylinder ultimately actuating the clutch fingers to release the clutch and thus disengage drive from the crankshaft. When your foot is off the pedal, the spring pushes the pressure plate against the clutch disc, which in turn presses against the flywheel; this locks the engine to the transmission input shaft, causing them to rotate at the same speed.

The clutch system is of conventional design comprising the following major components:

- Clutch master cylinder and pressure pipes
- Concentric slave cylinder outlet assembly and peak torque limiter
- Vibration damper (Left hand drive vehicles only)
- Concentric slave cylinder
- Clutch cover assembly
- Clutch driven plate
- Flywheel

CLUTCH MASTER CYLINDER



E88782

Item	Part Number	Description
1	-	Clutch master cylinder

The clutch master cylinder is attached directly to the pedal box assembly, located in the driver's footwell.

The cylinder contains a piston assembly, with a push rod connected to the clutch pedal and spring. When the clutch pedal is depressed, it pushes on the piston, via a linkage. Pressure builds in the cylinder and lines as the clutch pedal is depressed further.

The cylinder has 2 hydraulic connections:

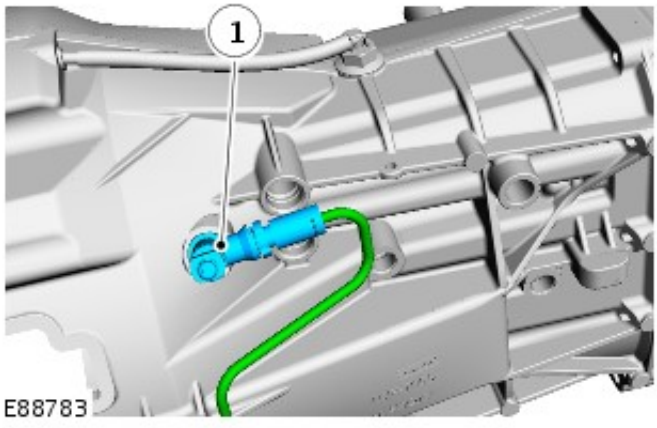
- A low pressure feed pipe (providing fluid supply from the brake fluid reservoir)
- A high pressure pipe

The pedal travel is constrained by an 'up-stop' contained within the master cylinder and a 'down-stop' contained within

the pedal box.

CONCENTRIC SLAVE CYLINDER OUTLET ASSEMBLY

• NOTE: Right hand drive vehicle shown.



Item	Part Number	Description
1	-	Slave cylinder outlet assembly and peak torque limiter

The concentric slave cylinder outlet assembly connects the external pipes with the release system contained within the clutch housing. A securing bracket locates the assembly in the correct orientation and a seal is provided between the assembly and the clutch housing.

Contained within the slave cylinder outlet assembly is a peak torque limiter. This component is designed to restrict the hydraulic fluid flow during the clutch pedal up-stroke. Under normal pedal actuation this restriction can not be detected, but in the event of an unintentional pedal release (e.g. wet shoe slipping off the clutch pedal) the peak torque limiter limits the fluid return rate and protects the transmission and driveline form excessive shock loads, which might cause damage.

On left hand drive vehicles, the hydraulic pipework contains an anti-vibration damper plugged into the peak torque limiter. This is used to reduce pedal roar/vibrations during clutch operation.

CONCENTRIC SLAVE CYLINDER

The concentric slave cylinder assembly contains the release bearing and the hydraulic slave cylinder. The assembly is attached to the front end of the transmission via 3 bolts. These bolts are asymmetrically positioned to ensure correct angular location of the slave cylinder, which is also spigot-mounted for positional fit. In its free condition the slave cylinder is fully extended, but it positions itself automatically as the clutch housing is fitted to the engine. The assembly requires no setting or adjustment.

CLUTCH COVER ASSEMBLY

The clutch cover assembly comprises a pressure plate, cover and diaphragm and is mounted on and rotates with the flywheel.

The pressure plate is machined to provide a smooth surface for the drive plate to engage on. Lugs on the outer diameter of the pressure plate connect it via leaf springs to the cover. The leaf springs have leaves, which assist in pulling the pressure plate away from the drive plate when the clutch pedal is depressed.

The cover houses all pressure plate components. Shouldered rivets support the diaphragm inside the cover. The rivets heads are chamfered to allow the diaphragm to pivot when pressure is applied to it by the release bearing. Holes in the cover locate on dowels on the flywheel and further holes provide for the attachment of the cover to the flywheel. Larger holes in the cover provide ventilation for the drive plate and pressure plate and flywheel contact surfaces.

The diaphragm comprises a cast ring with fingers. The diaphragm is attached to the cover with shouldered rivets. The inner head of each rivet is chamfered to allow the diaphragm to pivot when the clutch is depressed or released. When pressure is applied to the fingers of the diaphragm by the release bearing, the diaphragm pivots on the rivets and moves away from the pressure plate, releasing the force applied to the pressure plate and allowing the drive plate to slip between the pressure plate and the flywheel.

CLUTCH DRIVEN PLATE

The clutch driven plate is sandwiched between the flywheel and the pressure plate of the clutch cover assembly. The clutch driven plate has a splined hub, which engages with the splines on the primary shaft from the transmission. The splined hub is located in an inner plate, which contains 3 compression pre-damper springs. The inner plate is retained by the springs, which can compress in both directions to cushion engine vibration at idle speed. The inner plate is located on 4 larger compression springs, which are located in a central plate. The hub is sandwiched between the central plate and the friction damper. The friction damper comprises friction washers located between the hub and the central plate. The friction washers reduce transmission noises and vibrations due to engine cyclic excitation.

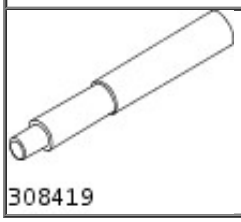
FLYWHEEL

The single mass flywheel is bolted to the flange of the engine crankshaft. A dowel ensures that the flywheel is correctly located. A ring gear is located on the outside diameter of the flywheel and is seated against a flange. The ring gear is an interference fit on the flywheel and is a serviceable item, which can be replaced if damaged or worn.

The operating face of the flywheel is machined to provide a smooth surface for the clutch driven plate to engage on.

Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Clutch Disc and Pressure Plate

Removal and Installation

Special Tool(s)	
 308419	Clutch alignment tool. 308-419

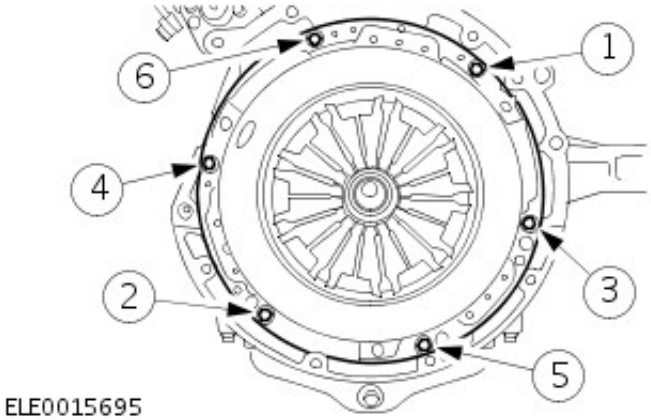
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the transmission.
For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Removal).

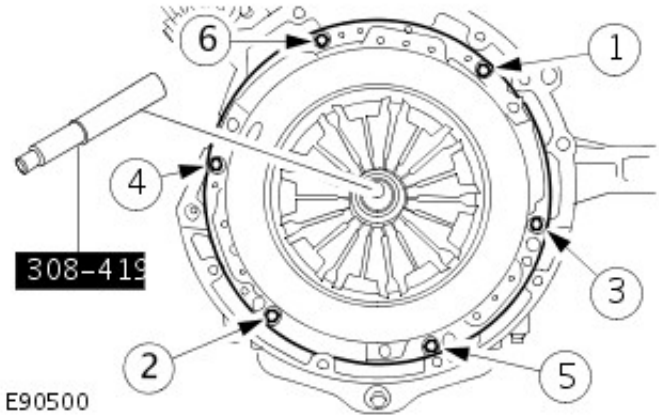


4. CAUTION: Loosen the clutch pressure plate bolts by 2 turns at a time in the sequence shown. Failure to follow this instruction may result in damage to the vehicle.

Remove the clutch disc and the clutch pressure plate.

- Remove and discard the 6 bolts.

Installation



1. CAUTIONS:

Make sure new bolts are installed. Failure to follow this instruction may result in damage to the vehicle.

Apply grease of the correct specification to the pilot bearing. Failure to follow this instruction may result in damage to the vehicle.

Tighten the bolts in the sequence shown. Failure to follow this instruction may result in damage to the vehicle.

• NOTE: Clean the component mating faces.

Using the special tool, install the clutch disc and the clutch pressure plate.

- Tighten the bolts to 29 Nm (21 lb.ft).

2. Remove the special tool.

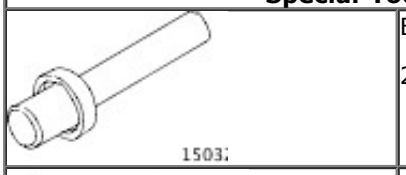
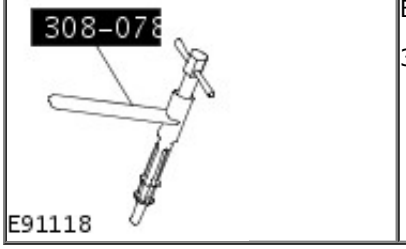
3. Install the transmission. For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle,

Installation).

4. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Pilot Bearing

Removal and Installation

Special Tool(s)	
	Bearing installer 205-081
	Bearing remover 303-078

Removal

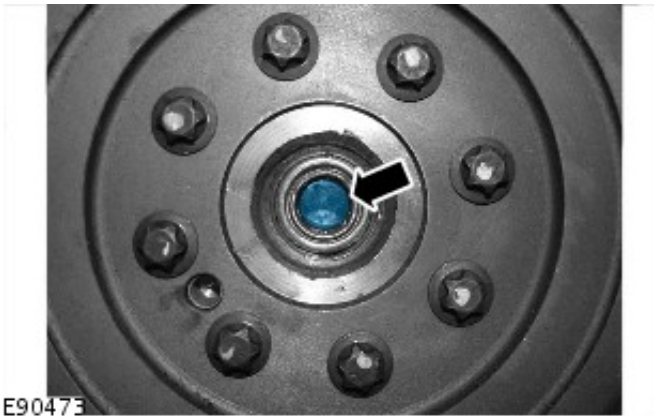
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

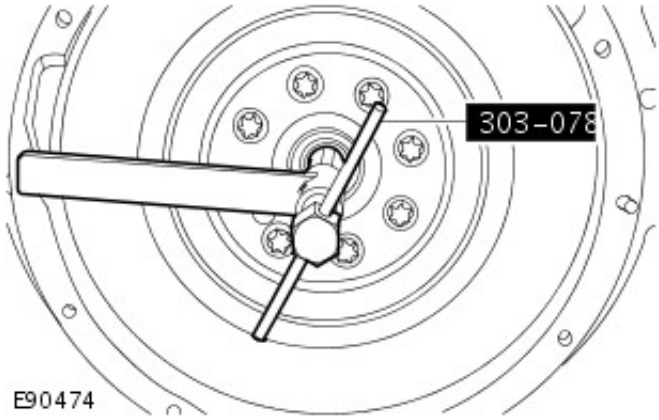
2. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the clutch disc and pressure plate.
   For additional information, refer to: Clutch Disc and Pressure Plate (308-01 Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

4. Using a suitable tool, break through the pilot bearing.

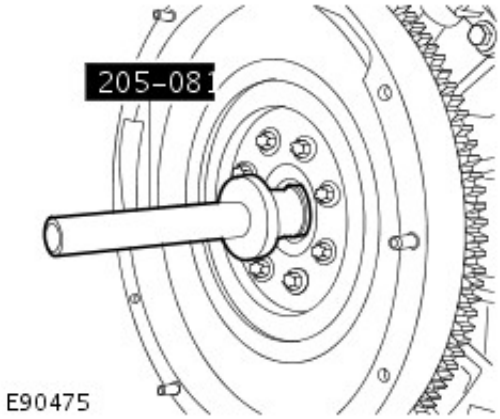


5. Using the special tool, remove the pilot bearing.



Installation

1. Using the special tool, install the pilot bearing.



2. Using the special tool, install the pilot bearing.

2. Install the clutch disc and pressure plate.
For additional information, refer to: Clutch Disc and Pressure Plate (308-01 Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Connect the battery gound cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Clutch Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Clutch slave cylinder bolts	10	7
Clutch master cylinder to pedal box bolts	23	17
Clutch pedal box to bulkhead bolts	23	17
Clutch master cylinder push rod nuts	23	17

Clutch Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Clutch ControlsVehicles With: 6-Speed Manual Transmission - MT82

Description and Operation

OVERVIEW

For additional information, refer to: Clutch - Vehicles With: 6-Speed Manual Transmission - MT82 (308-01 Clutch - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Clutch Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Clutch Slave Cylinder

Removal and Installation

Removal

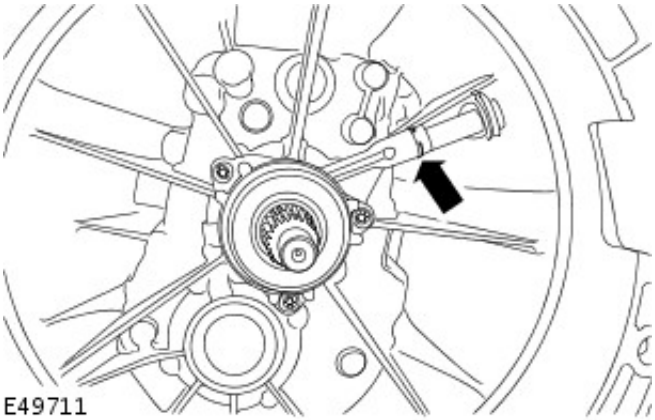
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

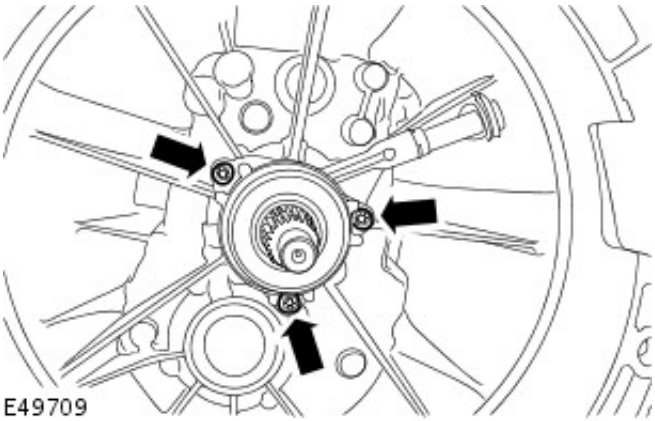
2. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the transmission.
   For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Removal).

4. Disconnect the fluid pipe.
   - Position an absorbent cloth to collect any fluid spillage.
   - Remove the clip.


E49711

5. Remove the clutch slave cylinder.
   - Remove the 3 bolts.


E49709

Installation

1. Install the clutch slave cylinder.
   - Tighten the bolts to 10 Nm (7 lb.ft).

2. Connect the fluid pipe.
   - Install the clip.

3. Install the transmission.
   For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Installation).

4. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Manual Transmission/Transaxle -

Lubricants, Fluids, Sealers and Adhesives

Item	Specification
Manual transmission fluid	WSD-M2C200-C
Super DOT 4 brake fluid	ESD-M6C57-A
Sealant	WSS-M2G348-A10
Grease	ESD-M1C220-A

Capacities

Capacities	Litres
MT82 transmission - Initial fill	2.4
MT82 transmission - Service fill	2.2

Description	Nm	lb-ft
Gearshift yoke securing nut	12	9
Clutch slave cylinder bolts	11	8
Reversing lamp switch	20	15
Transmission extension housing bolts	25	18
Transfer case bolts	45	33
Transmission bolts	40	30
RH transmission mount nut*	30	22
RH transmission mount bolts+	63	46
LH transmission mount nut*	30	22
LH transmission mount bolts+	63	46
Starter motor bolts	35	26
Fuel line support bracket nut	9	7
Clutch slave cylinder hose from the mounting bracket nut	25	18
Transmission wiring harness bracket nut and bolt	47	35
Transfer case breather pipe	15	11
RH earth cables to the transfer case bolt	9	7
LH earth cable to the transfer case nut	45	33
Rear driveshaft to the transfer case nut	50	37
Tail pipe to the intermediate pipe nut	25	18

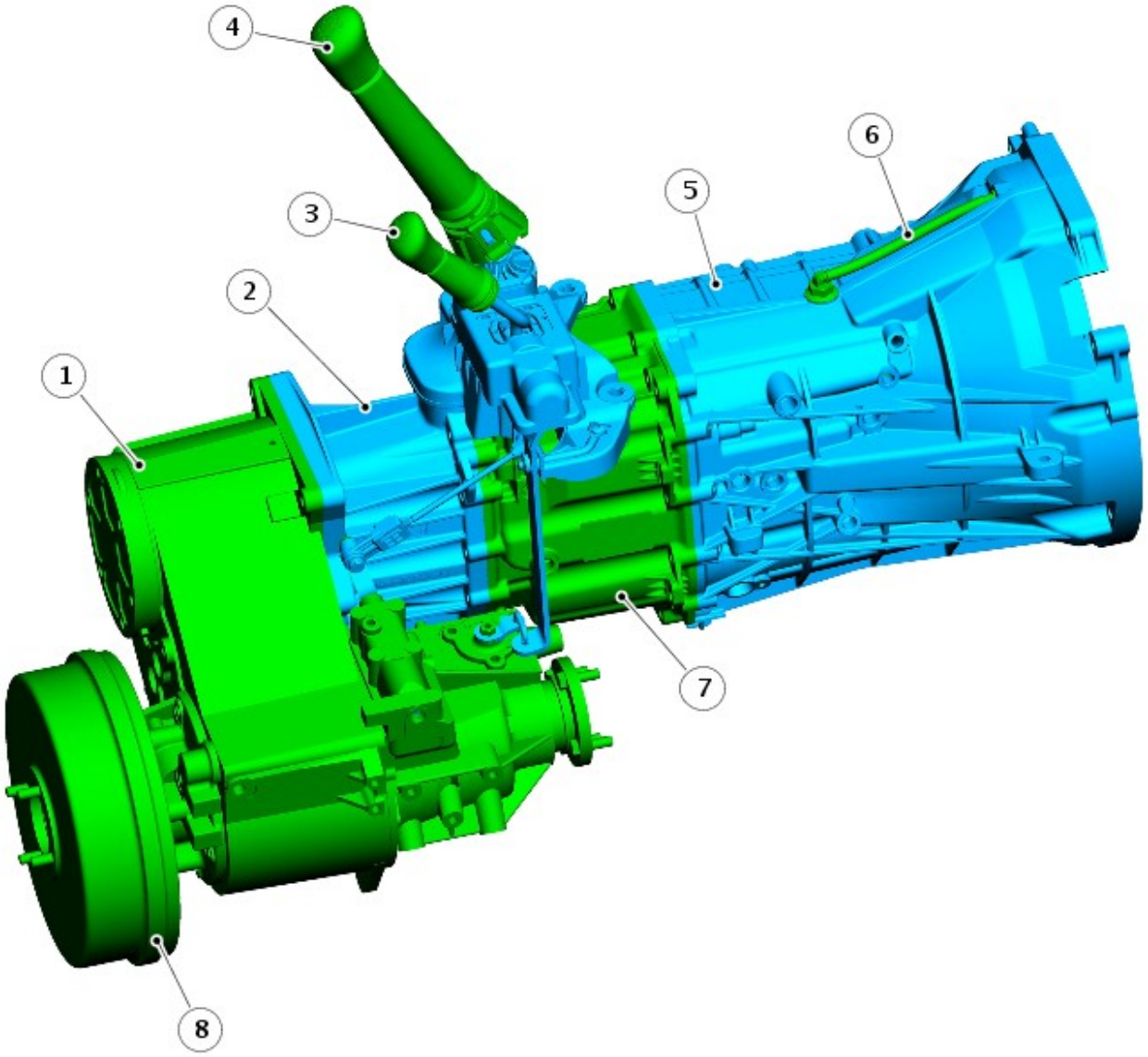
*If re-using nuts on vehicles built prior to VIN732932, tighten to 48 Nm. If replacing nuts, tighten to 30 Nm.

+If re-using bolts on vehicles built prior to VIN732932, tighten to 85 Nm. If replacing bolts, tighten to 63 Nm.

Manual Transmission/Transaxle - Manual TransmissionVehicles With: 6-Speed Manual Transmission - MT82

Description and Operation

COMPONENT LOCATION



E87083

Item	Part Number	Description
1	-	Transfer box assembly
2	-	Transmission extension case
3	-	Transfer box selector lever
4	-	Gear selector lever
5	-	Transmission front casing
6	-	Breather pipe
7	-	Transmission housing
8	-	Transmission park brake

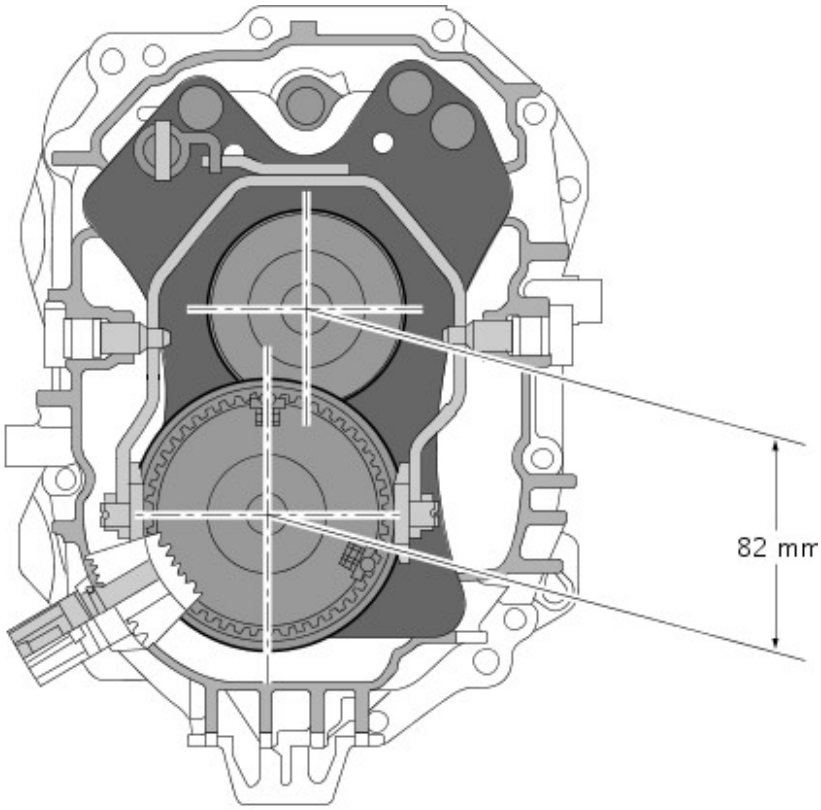
OVERVIEW

The MT82 manual transmission has 6 forward gears and a reverse. It is mounted longitudinally and has a maximum torque capacity of 360Nm. The aluminium die-cast transmission housing is bolted to the transfer box via an aluminium die-cast extension case.

The 6th gear ratio has been selected as an overdrive for economy and comfort at higher vehicle speeds. Optimum gear steps ensure highly fuel-efficient utilisation of the engine torque. This 6-speed transmission provides a wide ratio spread supporting both economy and drivability (e.g. low speed maneuvering/trailer towing).

The name MT82 is derived from the distance between the shafts in the transmission:

- **M** stands for manual
- **T** stands for transmission
- **82** is the distance between the 2 shafts in milimeters (mm)



E47709

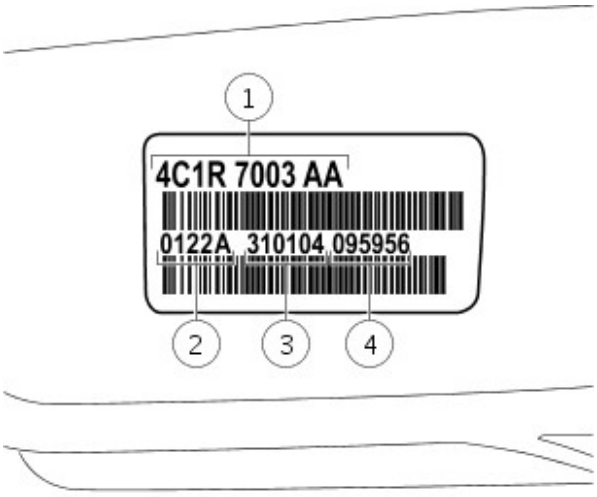
The transmission is a fill for life unit and no level check is required at service unless a leak is present.

Technical Data

Input Torque	Ratios							Dry Weight	Oil fill	Oil Specification
	1st	2nd	3rd	4th	5th	6th	Rev			
360Nm	5.441	2.840	1.721	1.223	1.00	0.742	4.935	50.8 kg	2.4L	WSD-M2C200-C

The input and output shafts are directly connected in 5th gear. This produces a gear ratio of 1:1.

Model Plate Label



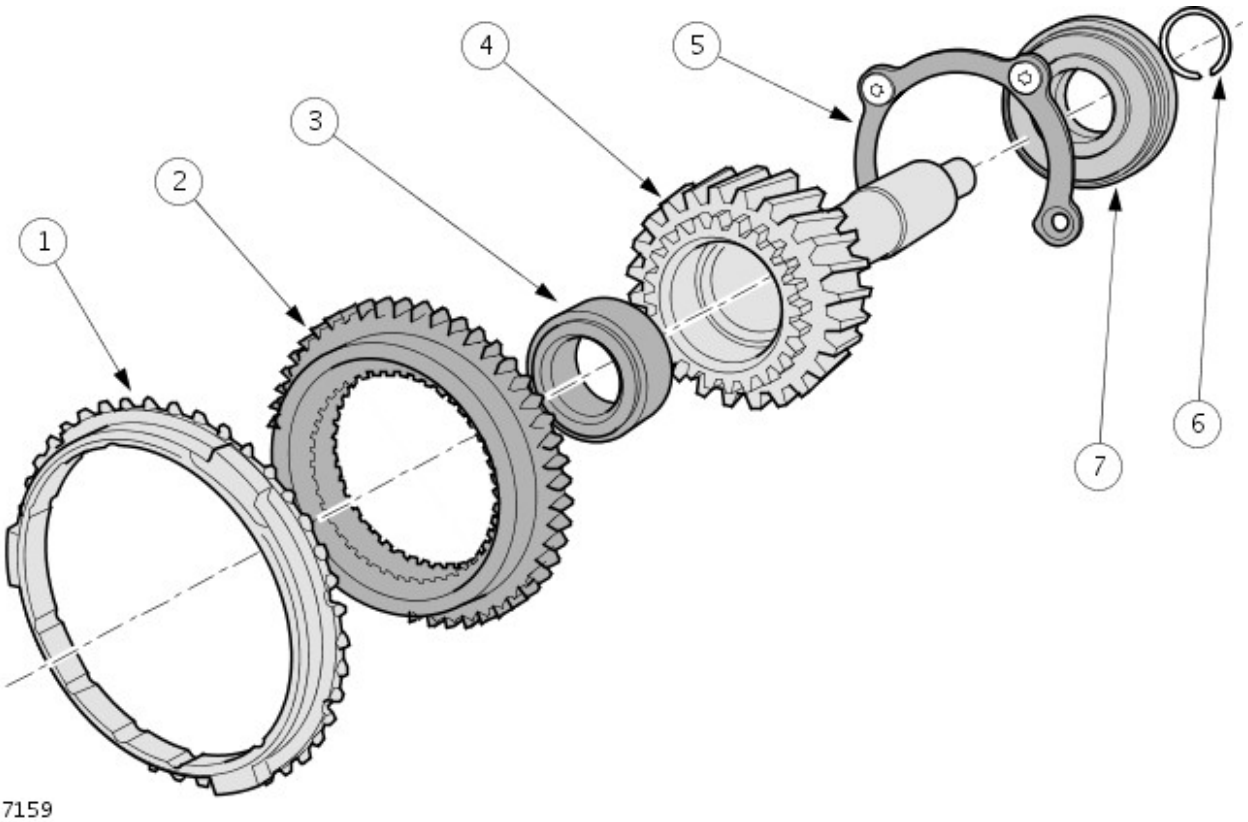
E48449

Item	Part Number	Description
1	-	Replacement part number
2	-	Place of manufacture (Halewood)
3	-	Vehicle build date
4	-	Build time

The model plate is located on the Right Hand (RH) side of the transmission, near the driveshaft drive flange.

It is only used to identify the transmission. All spare parts orders are still made using the Vehicle Identification number (VIN).

INPUT SHAFT



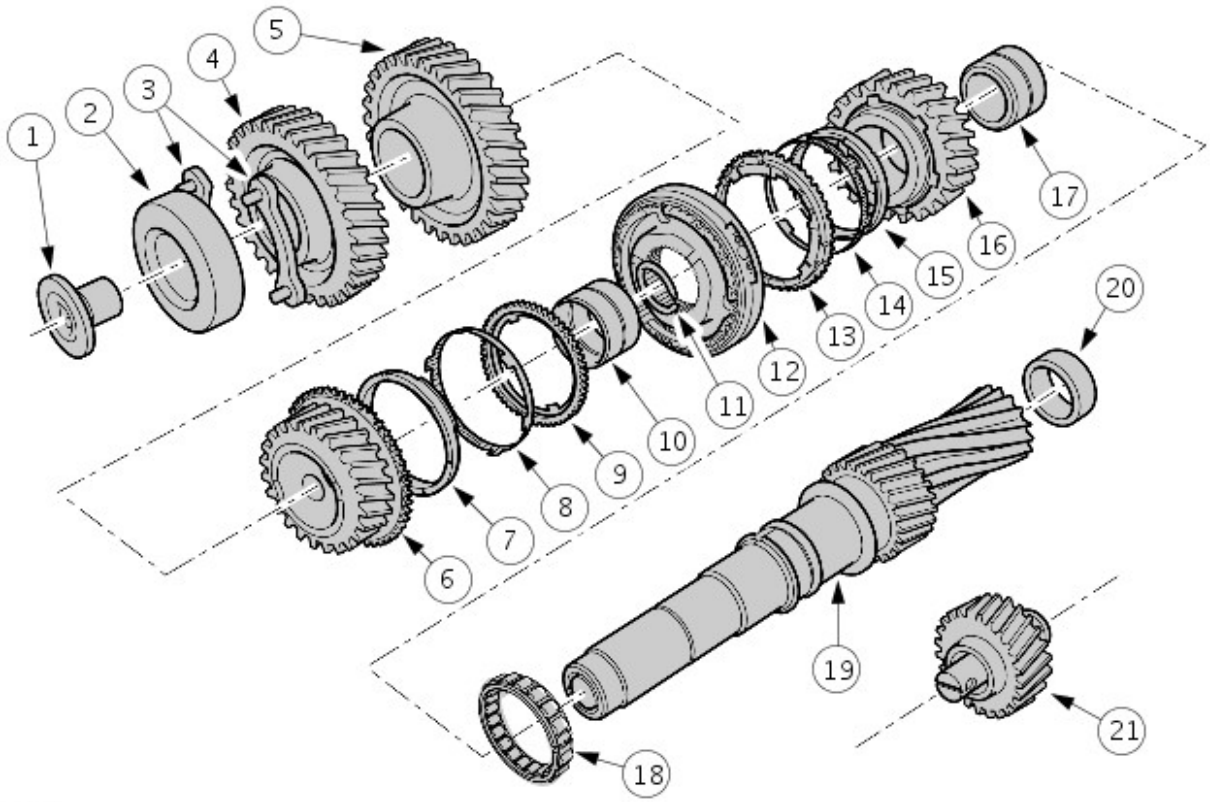
E47159

Item	Part Number	Description
1	-	5th gear synchroniser ring
2	-	Splined synchroniser, 5th gear
3	-	Output shaft pilot bearing
4	-	Input shaft
5	-	Bearing retaining plate
6	-	Ball bearing circlip
7	-	Input shaft ball bearing

The input shaft is rotationally mounted in the output shaft on the pilot bearing (3). In order to absorb the axial forces, the input shaft ball bearing (7) is additionally secured.

All the components on the input shaft can be serviced separately.

LAYSHAFT



E47153

Item	Part Number	Description
1	-	Retaining bolt
2	-	Ball bearing, layshaft
3	-	Retaining plate - bearing
4	-	Input pinion, layshaft
5	-	Gear - 6th gear
6	-	Gear wheel - 3rd gear
7	-	3rd gear synchroniser cone
8	-	Inner synchroniser ring
9	-	Outer synchroniser ring - 3rd gear
10	-	Needle bearing
11	-	Snap ring
12	-	3rd/4th gear synchroniser assembly
13	-	Outer synchroniser ring - 4th gear
14	-	Inner synchroniser ring
15	-	4th gear synchroniser cone
16	-	Gear wheel - 4th gear
17	-	Needle bearing
18	-	Centre bearing, layshaft
19	-	Layshaft
20	-	Roller bearing, layshaft
21	-	Reverse gear idler

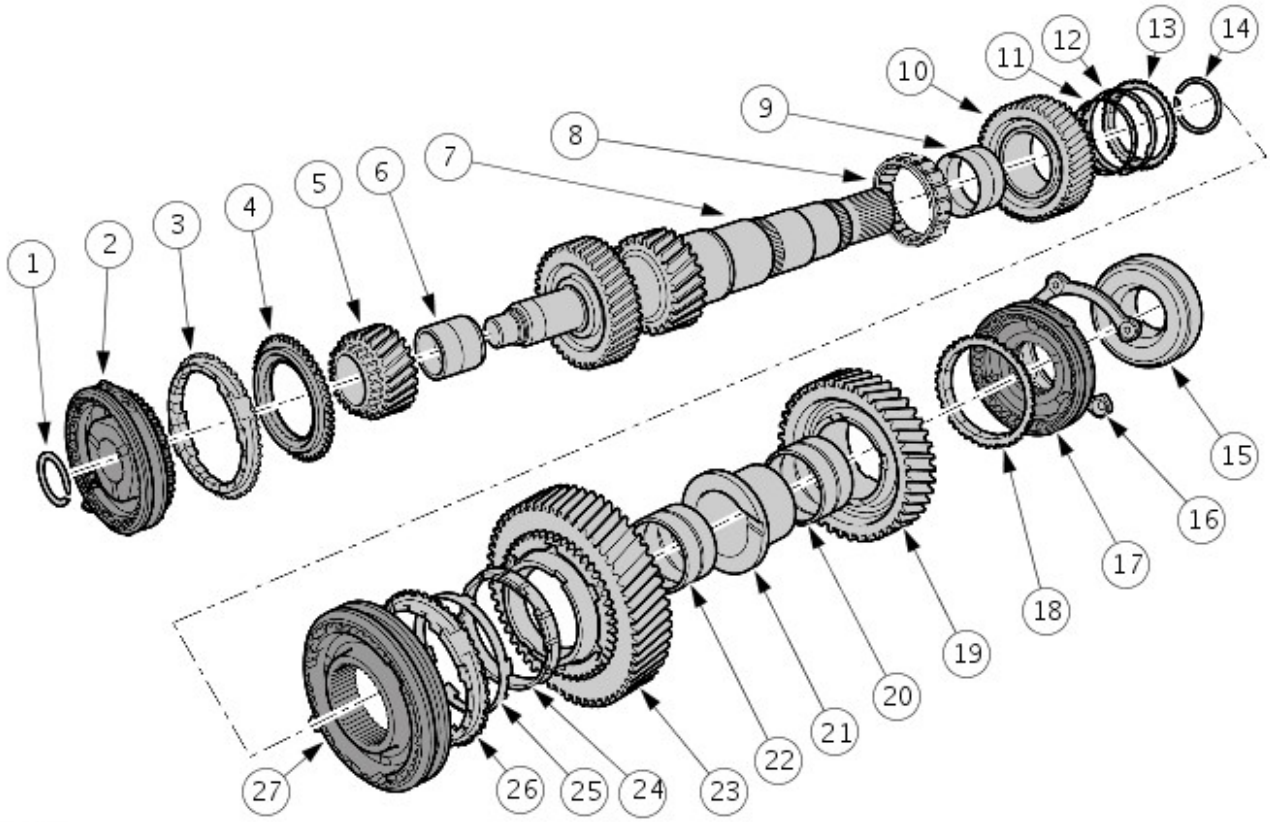
The layshaft transfers the torque from the input shaft onto the output shaft. Gear wheels and gears and the 3rd/4th gear synchroniser assembly are located on the shaft. First, 2nd and reverse gears are an integral part of the shaft.

The layshaft gearwheels and gears can be replaced individually. Because of improved manufacturing tolerances, it is no longer necessary to change the gears and gear wheels in pairs.

The layshaft is a solid shaft. In order to prevent the shaft from moving axially, it is additionally secured with a retaining bolt (1) and a bearing retaining plate (3).

The rotational direction of the output shaft is reversed by the use of the reverse gear idler (21).

OUTPUT SHAFT



E47148

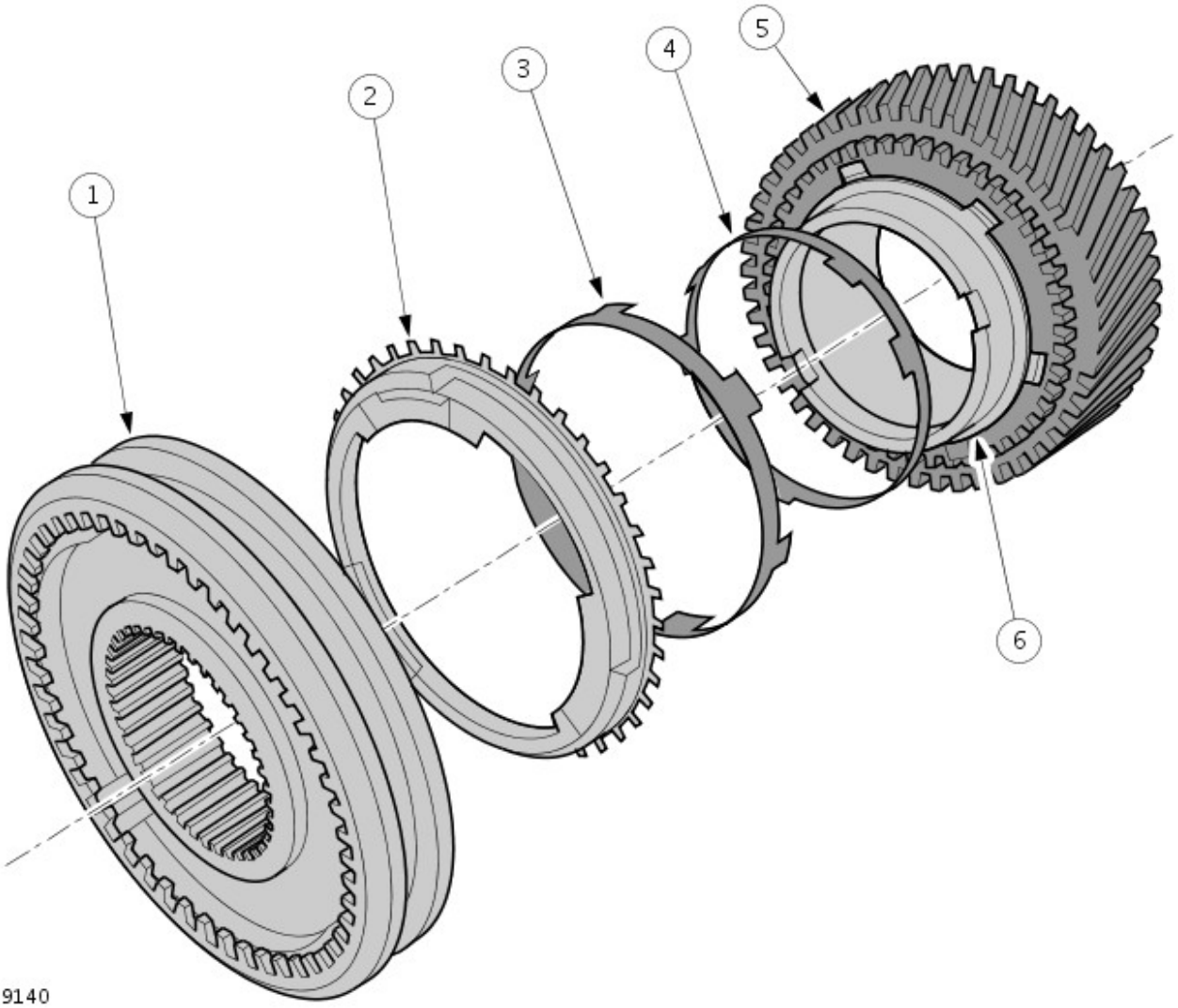
Item	Part Number	Description
1	-	Snap ring
2	-	5th/6th gear synchroniser assembly
3	-	6th gear synchroniser ring
4	-	Splined synchroniser, 6th gear
5	-	Gear wheel - 6th gear
6	-	Needle bearing
7	-	Output shaft
8	-	Centre bearing - output shaft
9	-	Needle bearing
10	-	Gear wheel - 2nd gear
11	-	2nd gear synchroniser cone
12	-	Inner synchroniser ring
13	-	Outer synchroniser ring - 2nd gear
14	-	Snap ring
15	-	Ball bearing, output shaft
16	-	Retaining plate - bearing
17	-	Reverse gear synchroniser assembly
18	-	Reverse gear synchroniser ring
19	-	Gear wheel - reverse gear
20	-	Needle bearing
21	-	Inner race - needle bearing
22	-	Needle bearing
23	-	Gear wheel - 1st gear
24	-	1st gear synchroniser cone
25	-	Inner synchroniser ring - 1st gear
26	-	Outer synchroniser ring - 1st gear
27	-	1st/2nd gear synchroniser assembly

The output shaft transfers torque through the output flange, to an extension shaft connected to the transfer box. 1st, 2nd, 6th and reverse gear wheels are located on the output shaft. 3rd and 4th gears are an integral part of the output shaft.

In a similar way to the input shaft, there is a splined synchroniser (4) pushed on the 6th gear gear wheel. This makes it possible to transfer the torque in 6th gear.

The output shaft gearwheels and gears can be replaced individually.

TRIPLE SYNCHRONISER ASSEMBLY



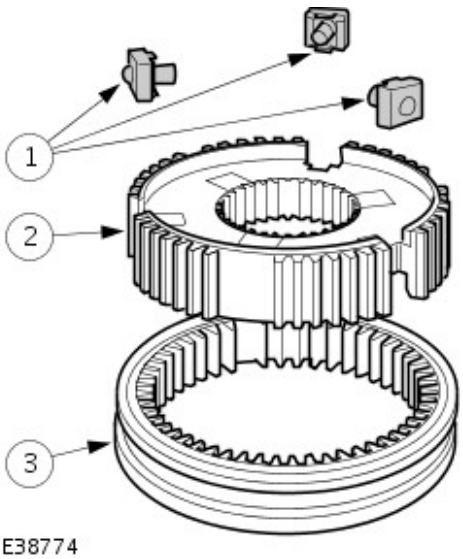
E49140

Item	Part Number	Description
1	-	1st/2nd gear synchroniser assembly
2	-	Outer synchroniser ring
3	-	Inner synchroniser ring
4	-	Synchroniser cone
5	-	Gear wheel
6	-	Conical surface

The Synchronisation assembly consists of 3 friction surfaces. The total friction surface of triple synchronisation is considerably increased by the additional conical surface (6). This leads to a reduction in the force needed to change into 1st or 2nd gear.

As the conical surface is part of the gear wheel, there is no need for an additional synchroniser ring.

SYNCHRONISER ASSEMBLY

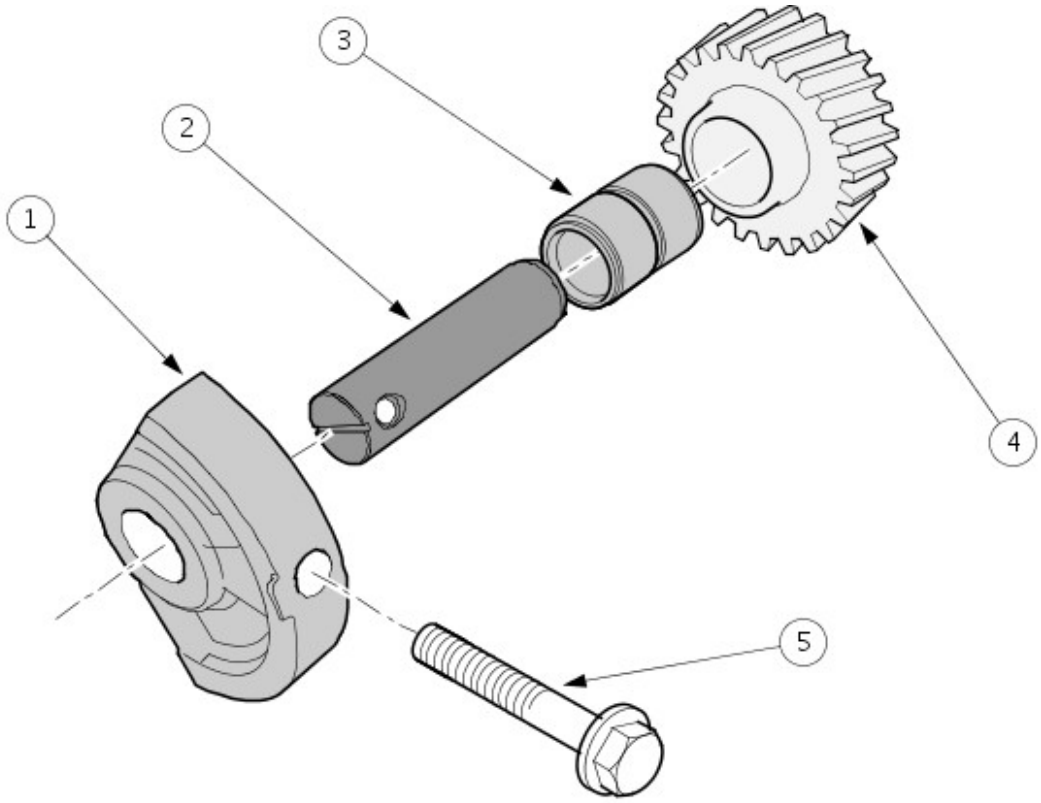


TIE38774

Item	Part Number	Description
1	-	Sliding block assembly
2	-	Synchroniser hub
3	-	Sliding collar

The pressure springs and detent balls of the sliding blocks are combined in one unit.

REVERSE GEAR IDLER



E47160

Item	Part Number	Description
1	-	Mounting
2	-	Reverse gear idler shaft
3	-	Needle bearing
4	-	Reverse gear idler
5	-	Retaining bolt - reverse gear mounting

The reverse gear idler allows the direction of rotation of the output shaft to be reversed. The reverse gear idler turns on a needle bearing, which runs on the reverse gear idler shaft. The shaft is retained by the mounting (1) and a locating bore in the transmission housing.

In order to absorb the radial forces, the reverse gear idler runs on an additional mounting.

If the reverse gear idler can be replaced as an individual unit.

Manual Transmission/Transaxle - Transmission Draining and Filling

General Procedures

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

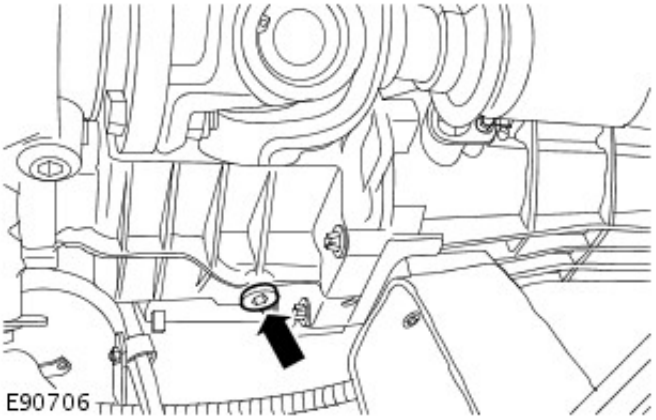
2. NOTE: The oil should be drained when the transmission is warm and the vehicle is standing on a level surface.

Position a container to collect the oil.

3. Clean the area surrounding the transmission drain plug.

4. Remove the transmission drain plug.

- Allow the oil to drain.



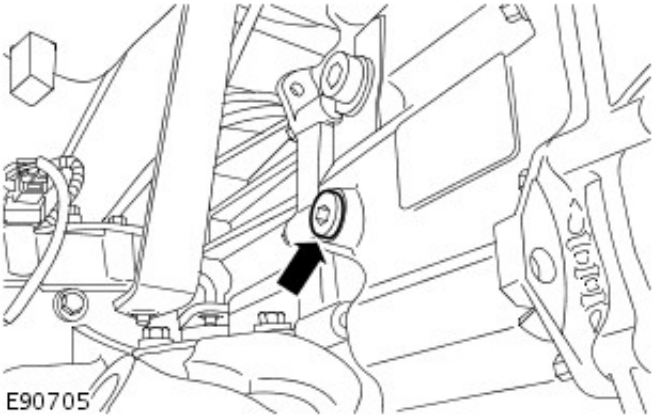
5. Clean transmission drain plug.

6. Install the transmission drain plug and clean any oil residue from the surrounding area.

- Tighten to 50 Nm (37 lb.ft).

7. Clean the area surrounding the transmission filler plug.

8. Remove the transmission filler plug.



9. Fill the transmission with the correct grade of oil.
For additional information, refer to: Specifications (308-03 Manual Transmission/Transaxle, Specifications).

10. Install the transmission filler plug and clean any oil residue from the surrounding area.

- Tighten to 35 Nm (26 lb.ft).

11. Remove the container.

12. Lower the vehicle.

Manual Transmission/Transaxle - Gearshift Control Shaft Seal

In-vehicle Repair

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

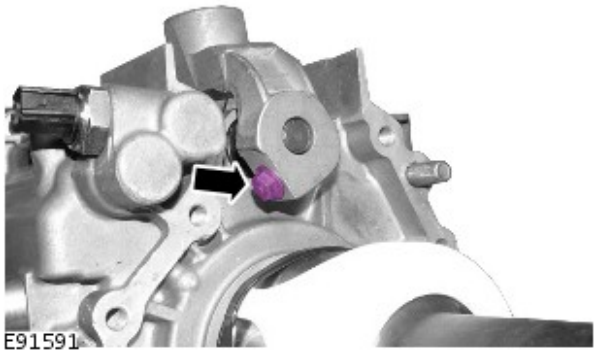
   Raise and support the vehicle.

3. Remove the transfer case.
   For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal).

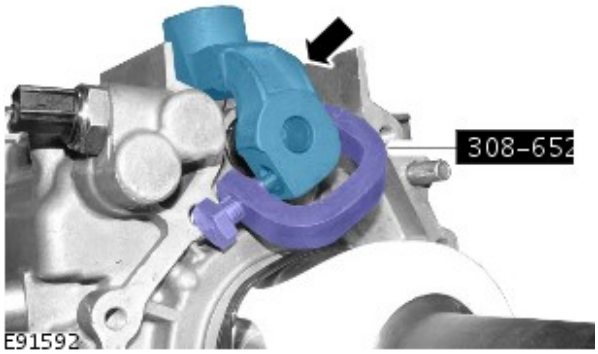
4. Remove the transmission extension housing.
   - Remove the 10 bolts.

E91607

5. Remove the gearshift yoke nut.


E91591

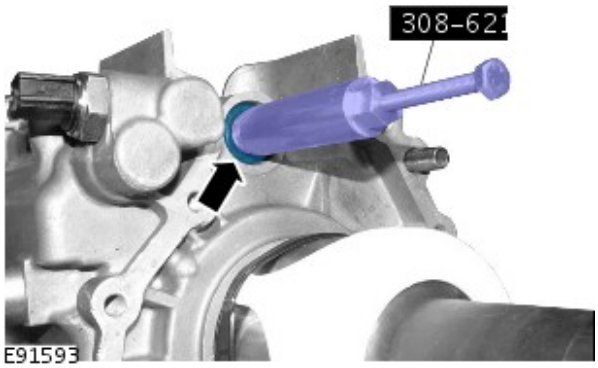
6. Using the special tool, remove the gearshift yoke.
   - Remove the pin.



E91592

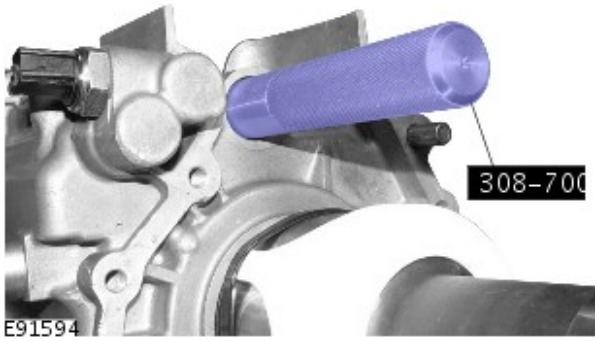
7. Using the special tool, remove the gearshift control shaft

seal.



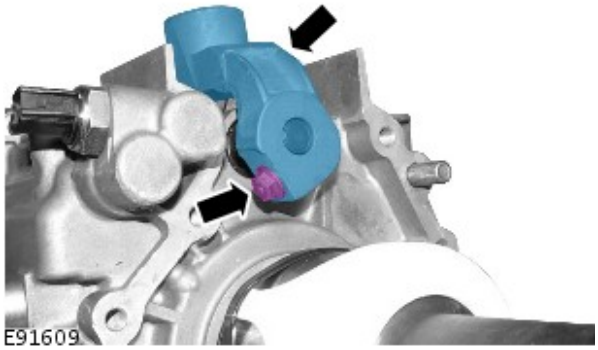
Installation

1. Using the special tool, install the gearshift control shaft seal.



2. Install the gearshift selector yoke.

- Tighten to 12 Nm (9 lb.ft).



3. Install the transmission extension housing.

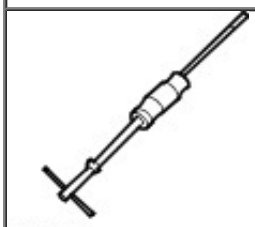
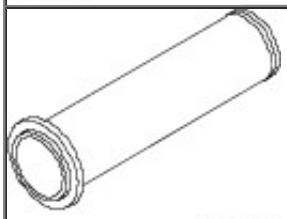
- Tighten to 25 Nm (18 lb.ft).

4. Install the transfer case.
For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Installation).

5. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Manual Transmission/Transaxle - Input Shaft Seal

In-vehicle Repair

Special Tool(s)	
 100012	Slide Hammer 100-012
E52741	Remover, Seals 308-615
 E49153	Installer Input Shaft Seal 308-605

Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

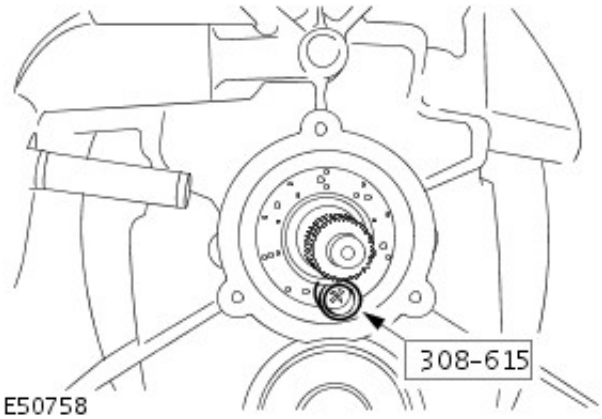
2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

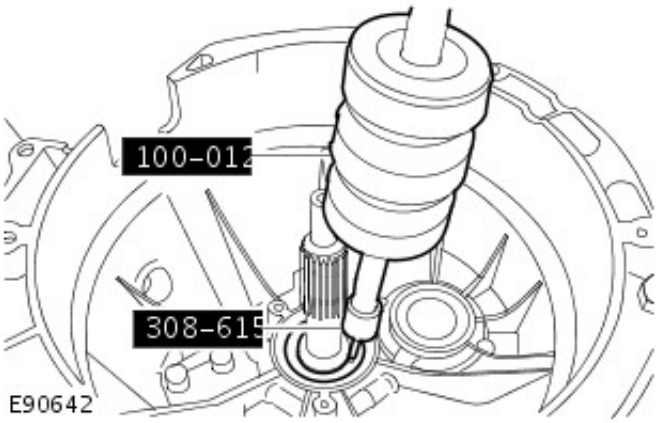
3. Drain the transmission.
For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

4. Remove the clutch slave cylinder.
For additional information, refer to: Clutch Slave Cylinder (308-02 Clutch Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

5. Install the special tool into the seal.

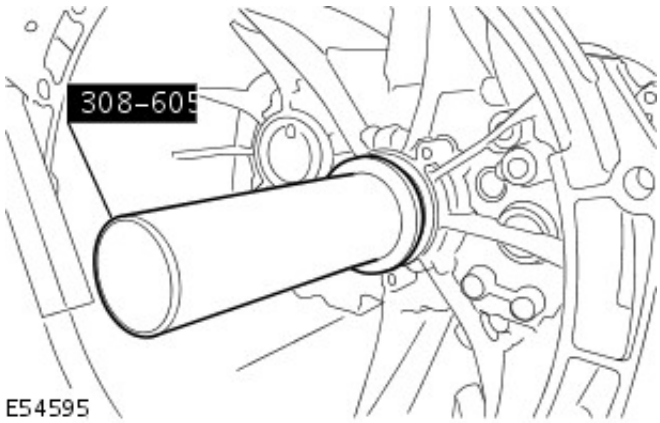


6. Using the special tools, remove and discard the input shaft



seal.

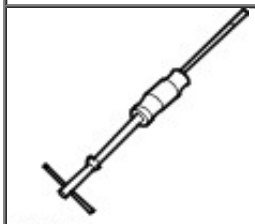
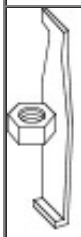
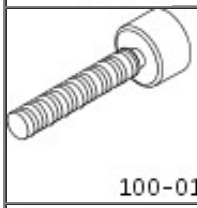
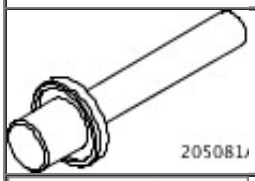
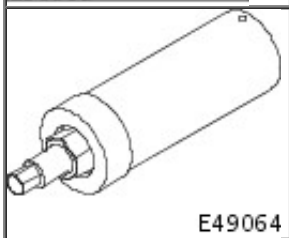
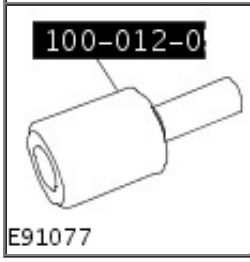
Installation



1. Using the special tool, install the new input shaft seal.
2. Install the clutch slave cylinder.
   For additional information, refer to: Clutch Slave Cylinder (308-02 Clutch Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Fill the transmission.
   For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

Manual Transmission/Transaxle - Output Shaft Seal

In-vehicle Repair

Special Tool(s)	
 100012	Slide Hammer 100-012
 308-37	Seal Remover Input and Output 308-375
 100-012-I	Slide Hammer Adaptor 100-012-01
E91080	Holding Tool, Output Flange 308-701
 205081A	Installer 205-081A
E90665	Long Legged Puller 308-516
 E49064	Installer, Output Drive Flange Seal 308-604
 E91077	Adapter Slide Hammer 100-012-05

Removal

1. Disconnect the battery ground cable.

For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the gearshift lever.
For additional information, refer to: Gearshift Lever (308-06 Manual Transmission/Transaxle External Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

4. Drain the transmission.
For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

5. Remove the transfer case.
For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal).

6. Remove the transmission extension shaft cover.

- Remove and discard the tie strap.

E91522

7. Using a suitable tool, remove the transmission extension shaft.

- Remove the seal.

E91523

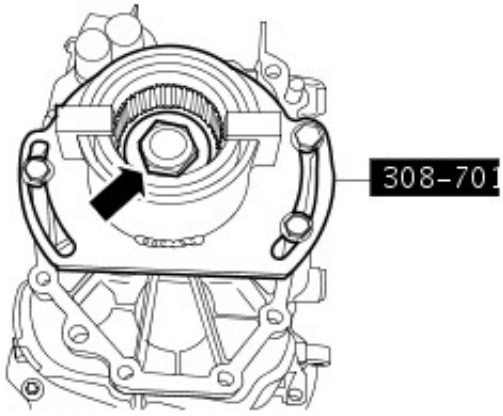
8. Remove the transmission extension housing.

- Remove the 10 bolts.

E91524

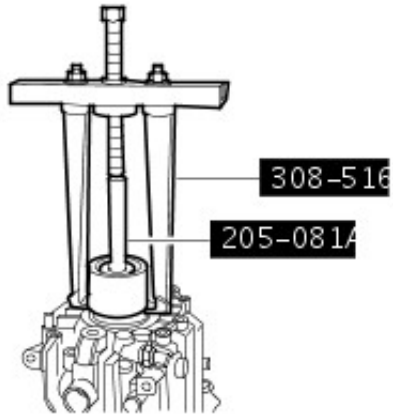
9. Using the special tool, remove the output flange securing

bolt.



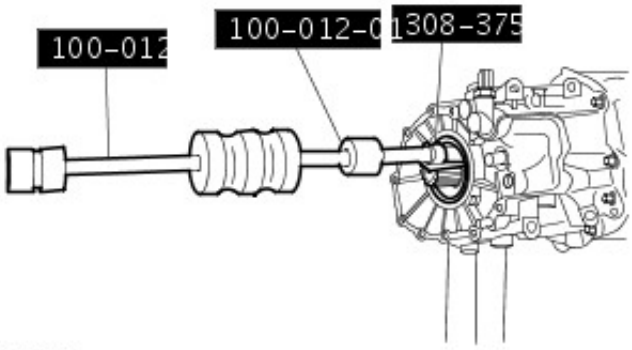
E89846

10. Using the special tools, remove the output flange.



E89847

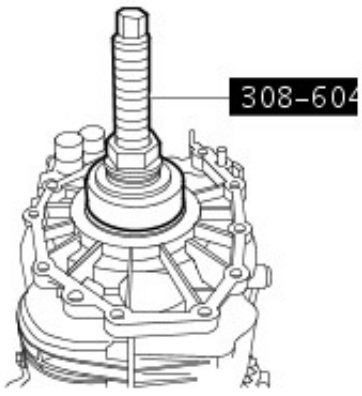
11. Using the special tools, remove and discard the output shaft seal.



E89852

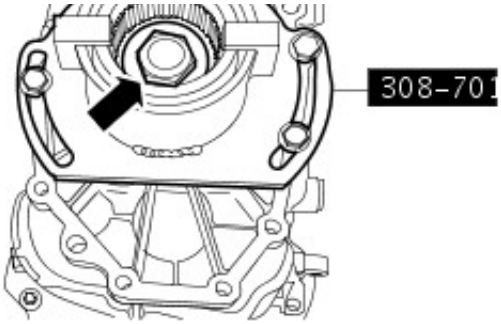
Installation

1. Using the special tool, install the output shaft seal.



E90432

2. WARNING: Care should be taken when using the hot air blower. Failure to follow this instruction may result in personal injury.



• NOTE: Heat the output flange to approx. 100 °C using a hot air blower.

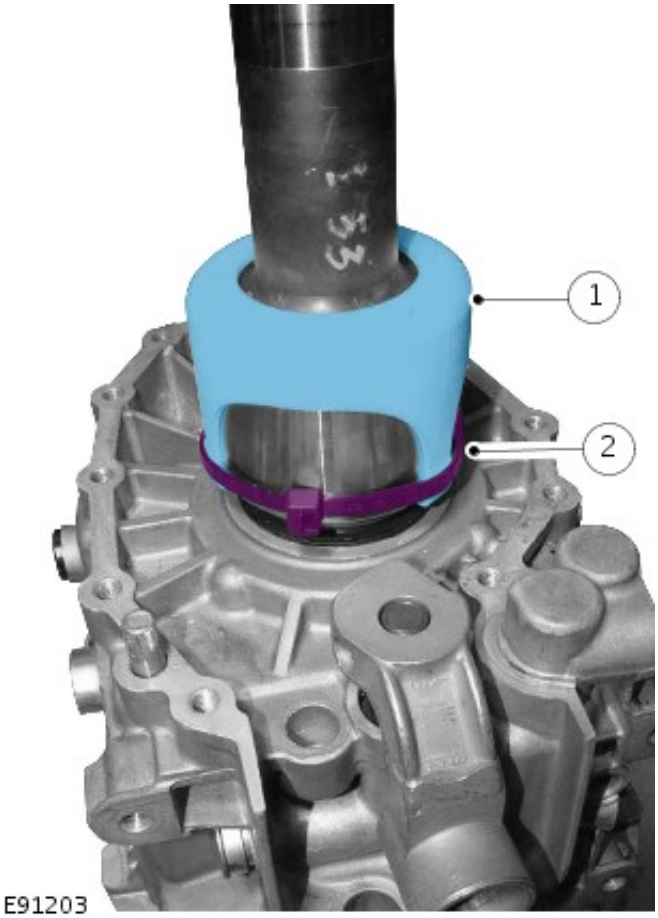
Using the special tool, install the transmission output flange.

- Tighten the bolt to 210 Nm (155 lb.ft).
- Loosen the bolt.
- Apply thread locking compound.adhesive
- Tighten the bolt to 180 Nm (133 lb.ft).

3. Install the transmission extension shaft.

- Install the seal.

4. NOTE: Make sure that the tie strap joint is between the



fingers of the extension shaft seal cover and that it has been cut flush.

Install the transmission extension shaft cover.

1. Install the cover.
2. Install the tie strap.

5. Install the transmission extension housing.

- Tighten the bolts to 25 Nm (18 lb.ft).

6. Install the transfer case.
For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Installation).

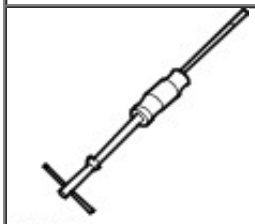
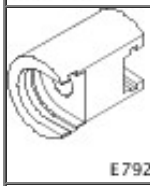
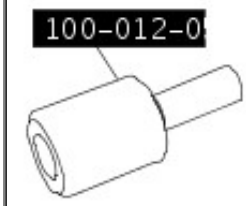
7. Fill the transmission.
For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General

Procedures).

8. Install the gearshift lever.
   For additional information, refer to: Gearshift Lever (308-06 Manual Transmission/Transaxle External Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
9. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Manual Transmission/Transaxle - Selector Shaft Detents

Removal and Installation

Special Tool(s)	
 100012	Slide Hammer 100-012
 E79252	Remover, Detent 308-657
 E91077	Adapter, Slide Hammer 100-012-05

General Equipment

Hammer

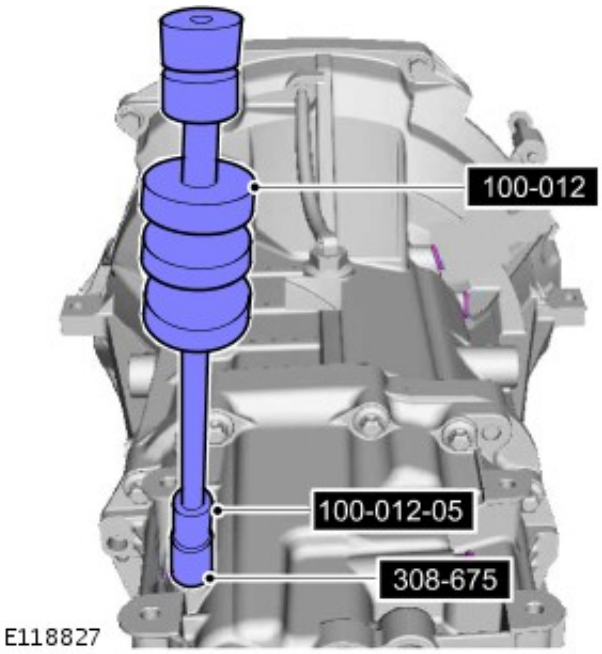
Soft Drift

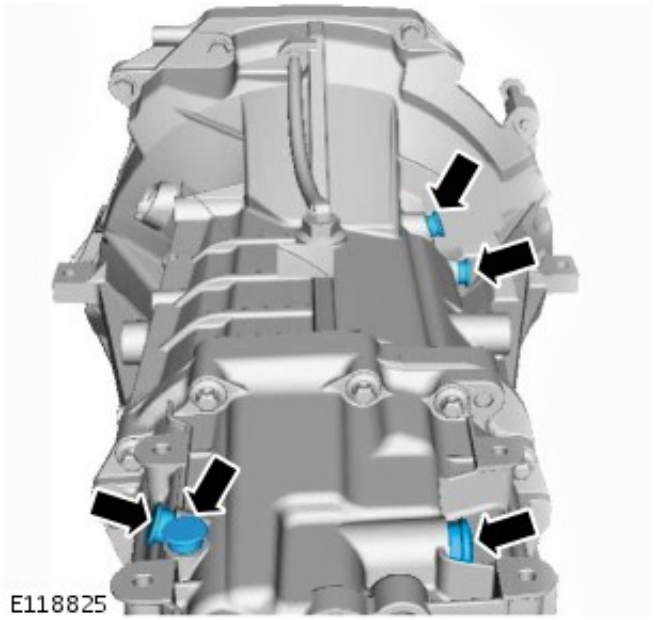
Removal

1. Remove the transmission.
For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Removal).

2. CAUTION: Make sure area surrounding component is clean.

Assemble the special tools.

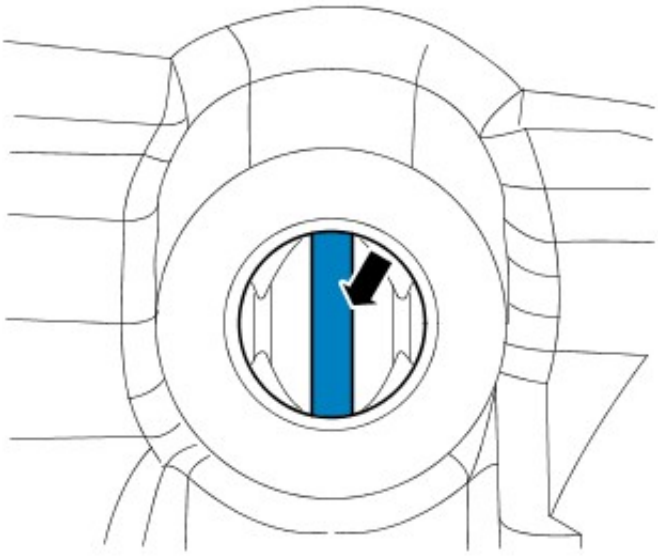




3. CAUTION: Make sure area surrounding component is clean.

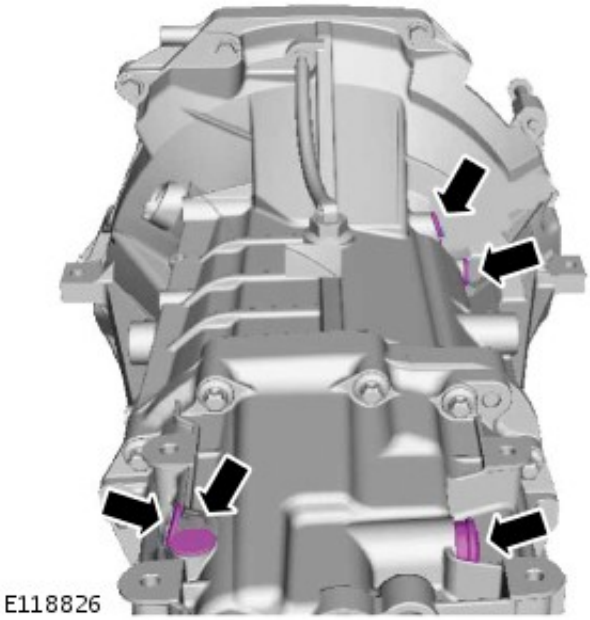
Using the special tools, remove the selector rod detents.

Installation



1. NOTE: If transmission is stuck in gear, carefully manipulate selector mechanism using a suitable flat bladed screwdriver.

Make sure all gear selector rods are aligned as shown and the gear selector linkage is free to move.



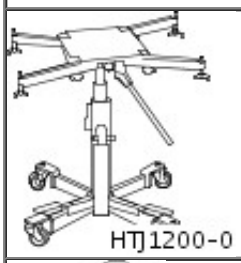
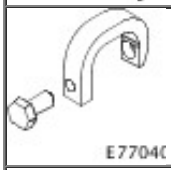
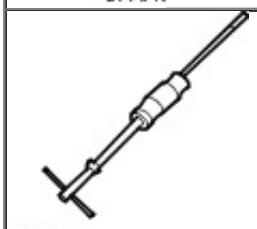
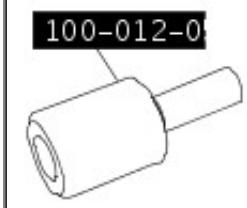
2. CAUTION: Make sure area surrounding component is clean.

• NOTE: New selector rod detents must be seated flush with transmission casing as necessary.

Using a suitable hammer and soft drift, install the selector rod detents.

3. Install the transmission.
For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Installation).

Manual Transmission/Transaxle - Transmission
Removal

Special Tool(s)	
 HTJ1200-0	Powertrain Assembly Jack HTJ1200-02
 E77040	Remover, Slider 308-652
 100012	Slide Hammer 100-012
 100-012-0 E91077	Adapter Slide Hammer 100-012-05

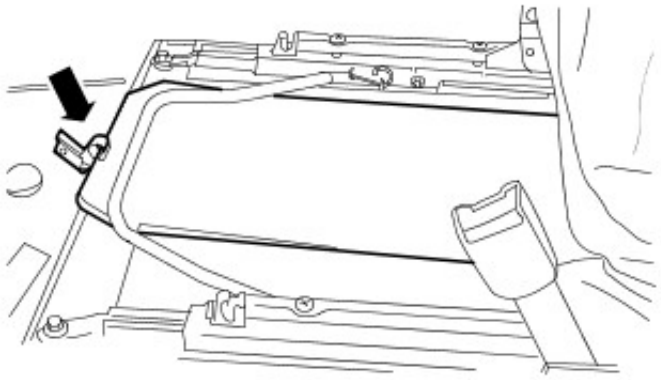
Removal

1. Open the front door.

2. Remove the front seat cushion assembly.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

3. Remove the battery cover.

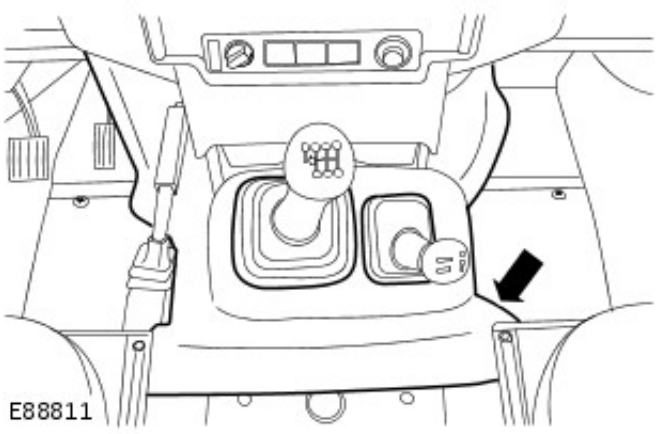
- Release the clip.


E89791

4. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

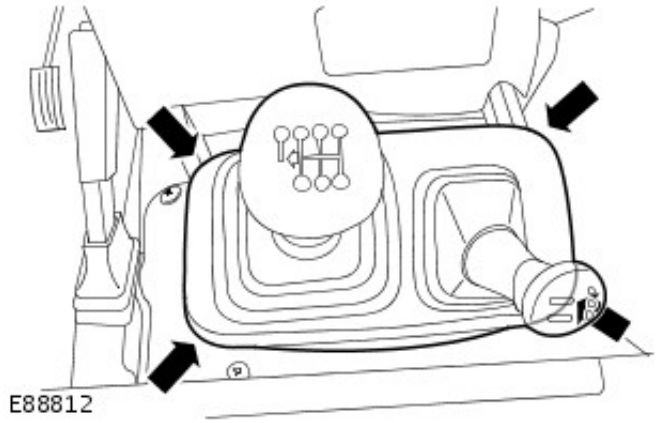
5. Remove centre floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

6. Remove the transmission cover panel carpet.



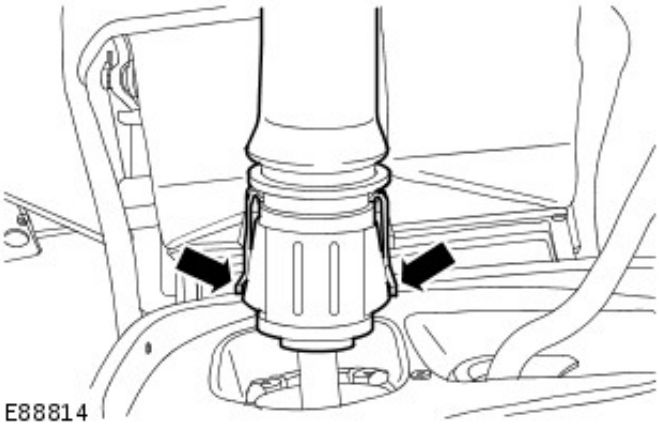
7. Release the gear selector lever gaiter.

- Release the gear selector lever gaitor from the transmission tunnel.
- Release the gear selector lever gaiter from the high-low selector lever.



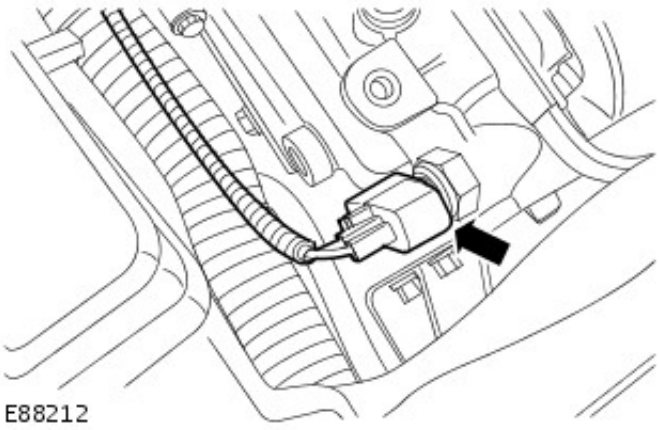
8. WARNING: The gearshift lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Remove the upper gear change lever.



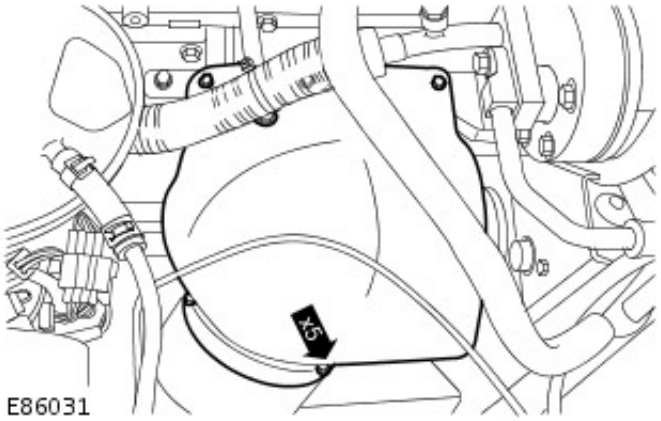
9. Remove the gear selector lever gaiter.

10. Disconnect the reversing lamp switch electrical connector.



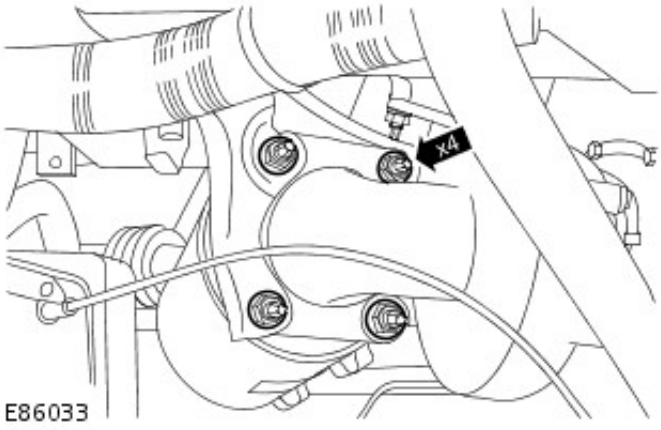
11. Open bonnet for access.

12. Remove the turbocharger heat shield.



- Remove the 5 bolts.

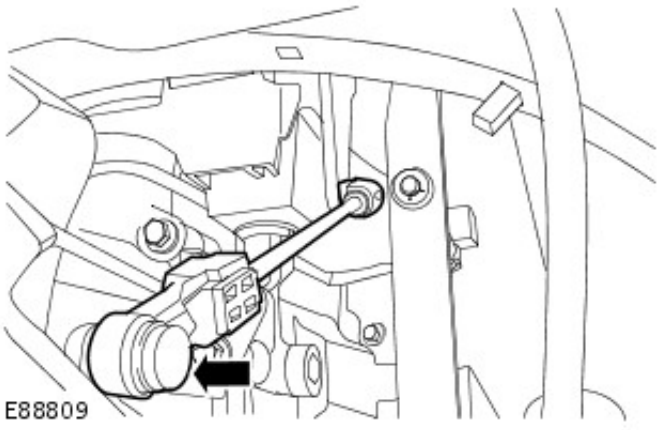
13. Remove the 4 catalytic converter securing studs.



14. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

15. Release the high-low selector rod ball joint from the transfer gearbox.



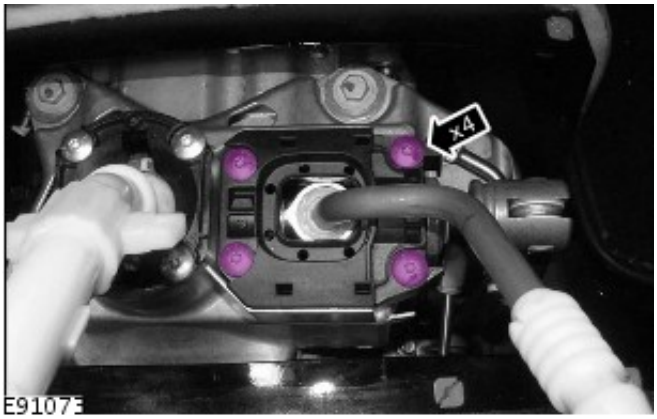
16. Lower the vehicle.

17. Open the front door.

18. Remove the foam pad from around the selector levers.

E91071

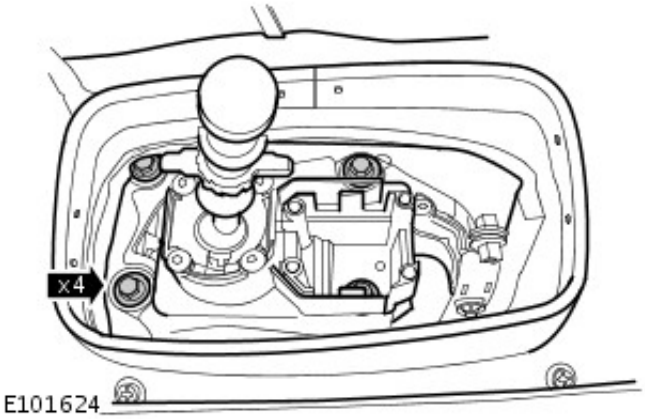
19. Remove the 4 high-low selector lever securing bolts.



E91073

20. Remove the high-low selector lever.

21. Remove the 4 gear selector housing securing bolts.

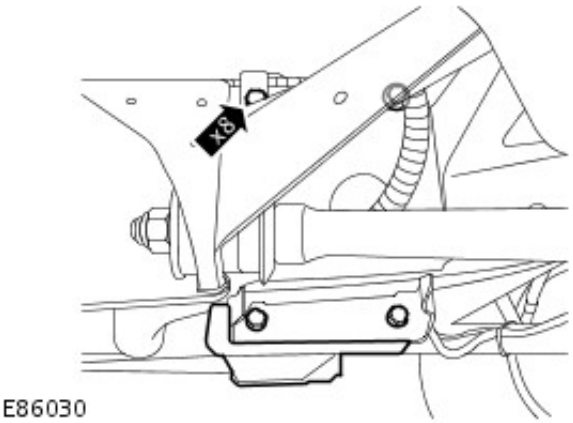


E101624

22. NOTE: Left-hand side shown, right-hand side similar.

Remove the chassis cross member.

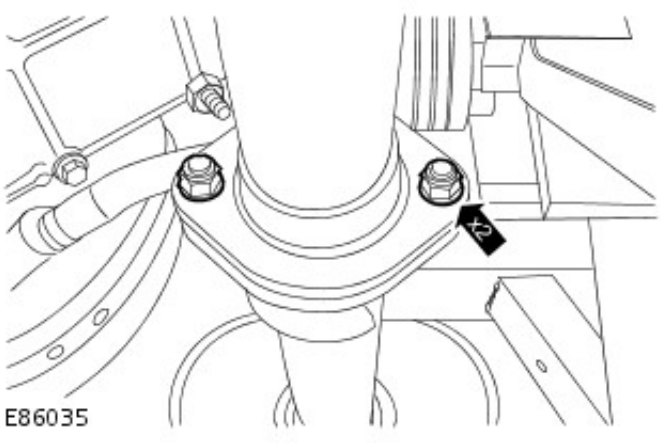
- Remove the 8 bolts.



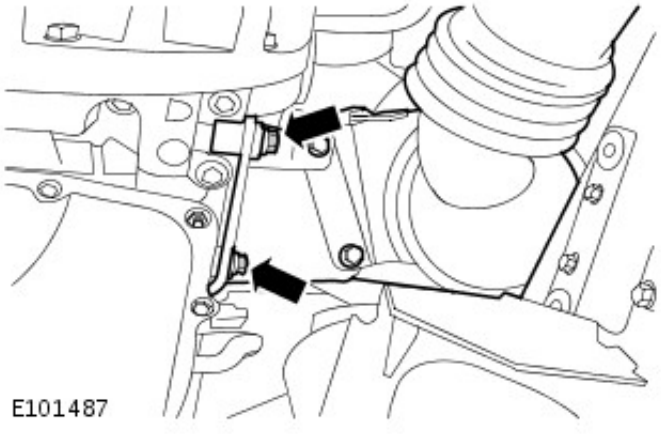
E86030

23. Remove the front driveshaft.
For additional information, refer to: Front Driveshaft (205-01 Driveshaft, Removal and Installation).

24. Remove the 2 catalytic converter to intermediate pipe

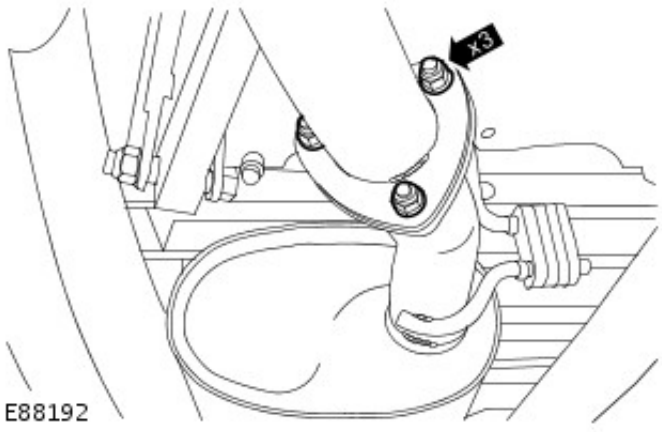


24. Remove the 2 catalytic converter to intermediate pipe securing nuts.

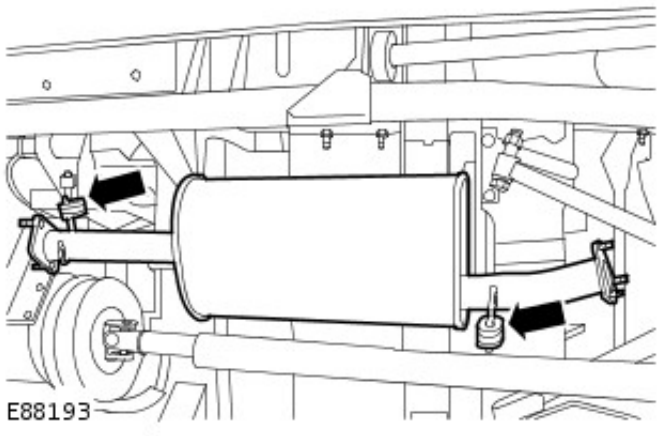


25. Remove the 2 catalytic converter mounting bracket securing bolts.

26. Remove the catalytic converter.



27. Remove the tailpipe and muffler, to intermediate pipe securing nuts.

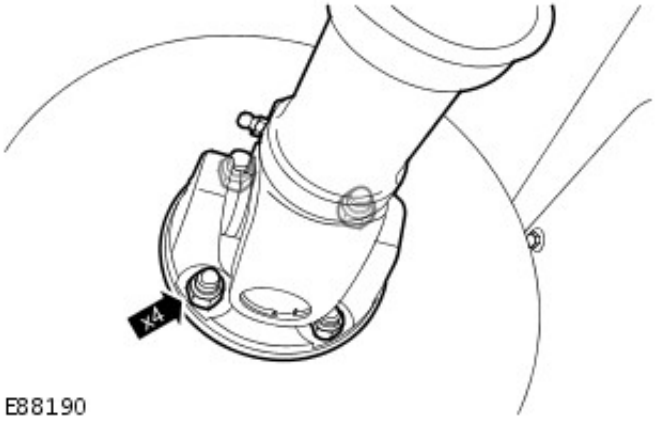


28. Remove the intermediate pipe and muffler.

29. Displace and reposition the rear driveshaft.

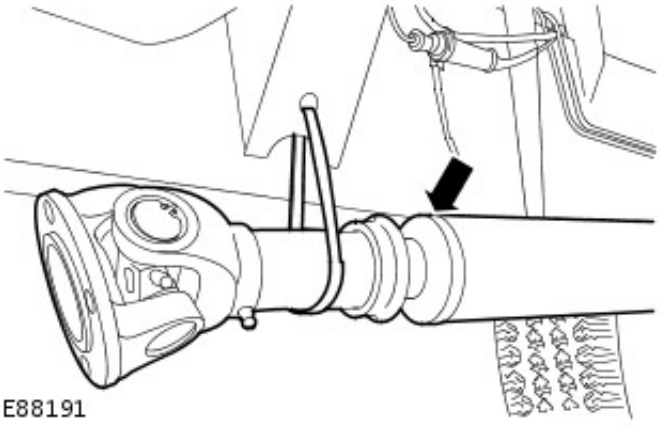
29. Displace and reposition the rear driveshaft.

- Mark the position of the driveshaft in relation to the drive pinion flange.
- Remove the rear driveshaft to transfer gearbox securing nuts.



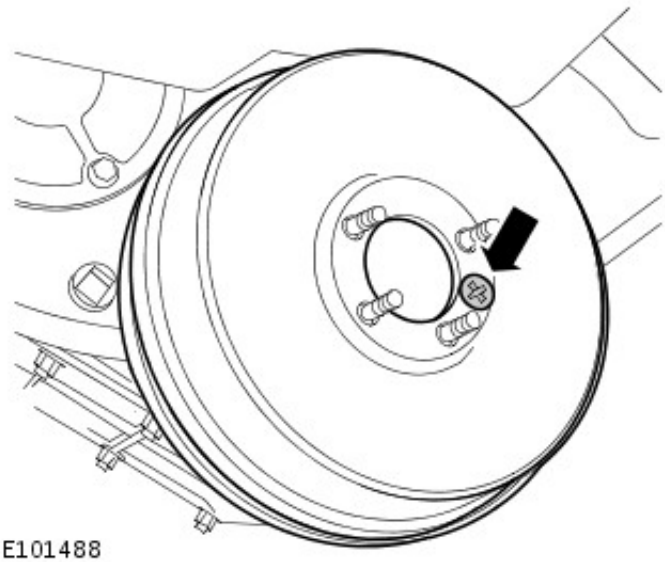
E88190

30. Using a suitable tie strap, secure the rear driveshaft to the chassis.


E88191

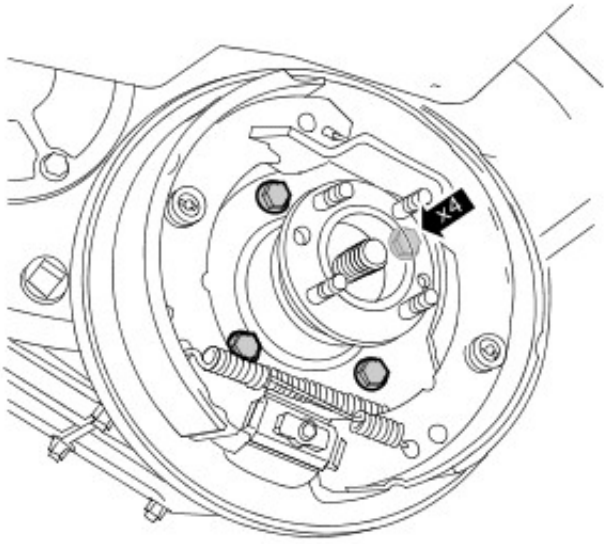
31. Remove the parking brake drum.

- Remove the securing screw.

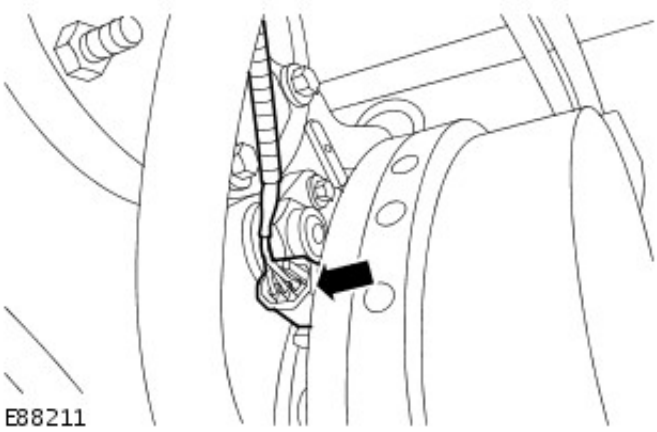

E101488

32. Remove the parking brake assembly and tie aside.

32. Remove the parking brake assembly and tie aside.

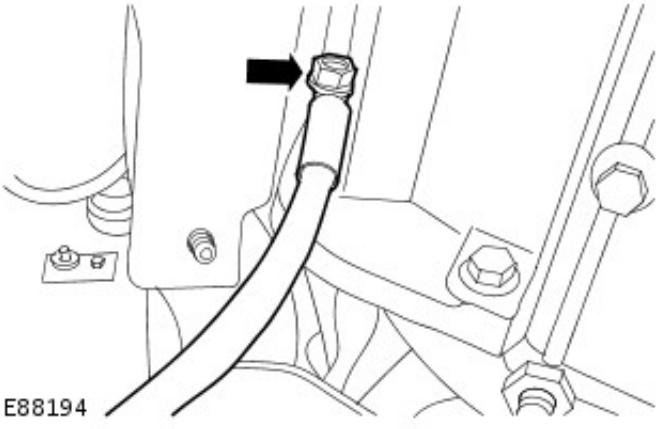


E101489



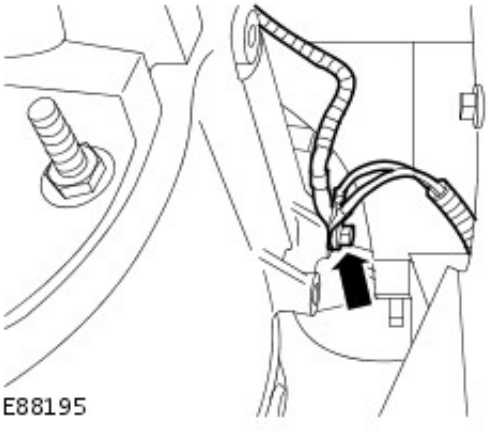
E88211

33. Disconnect the electronic speedometer drive electrical connector from the transfer gearbox.



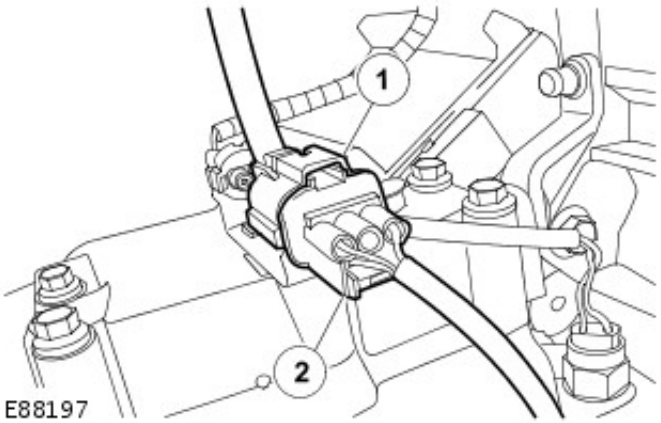
E88194

34. Remove the nut and disconnect the LH earth cable from the transfer gearbox.



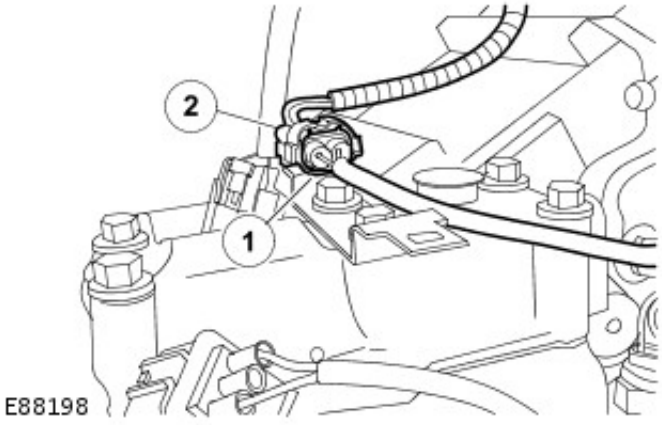
E88195

35. Remove the bolt securing the RH earth cables from the transfer gearbox.



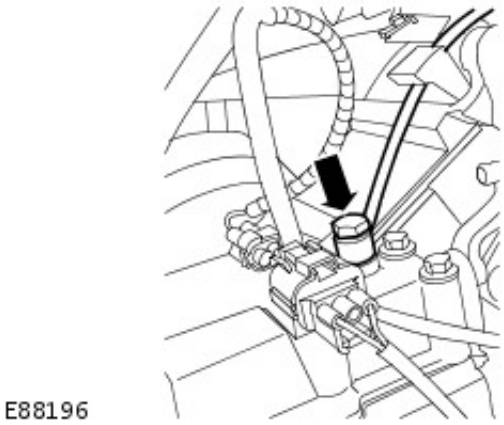
36. Displace and reposition the high-low detection switch electrical connector away from the transfer gearbox.

- Disconnect the high-low detection switch electrical connector.



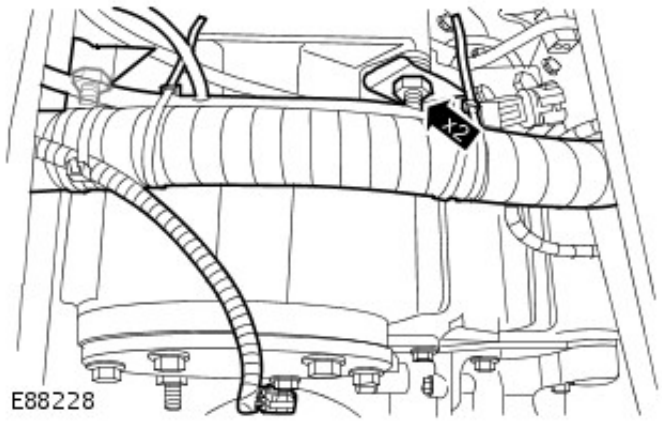
37. Disconnect the differential lock detection switch electrical connector.

- Release the electrical connector from the bracket.



38. Release the breather pipe from transfer gearbox.

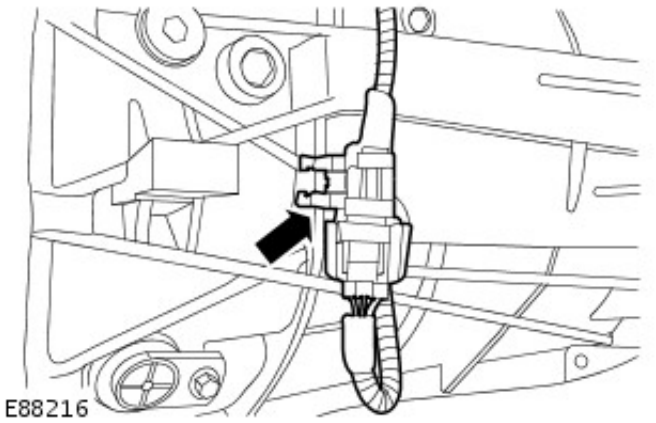
- Remove the securing bolt.
- Remove and discard the 2 sealing washers.



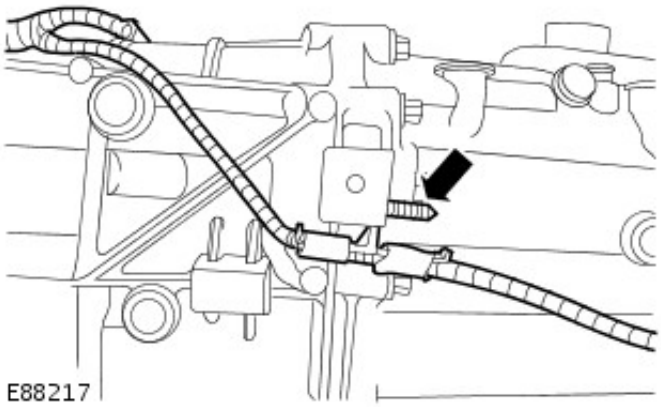
39. Remove the transmission harness retaining bracket securing nut and bolt and reposition the harness.

40. Release the transmission wiring harness connector and

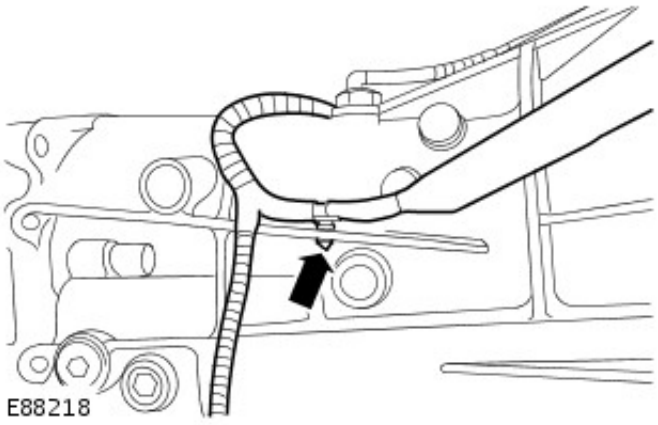
40. Release the transmission wiring harness connector and bracket from the RH side of the transmission.


E88216

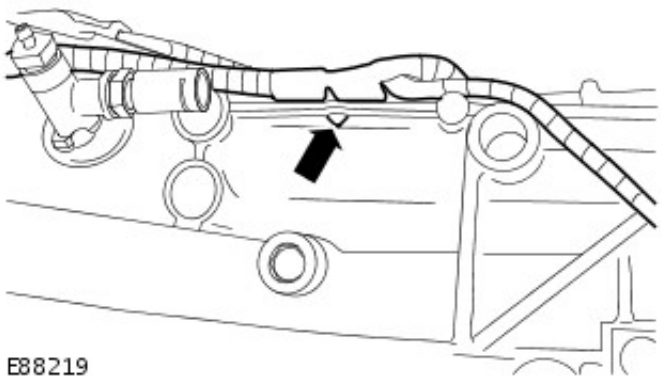
41. Release the transmission wiring harness securing clip from the LH side of the transmission.


E88217

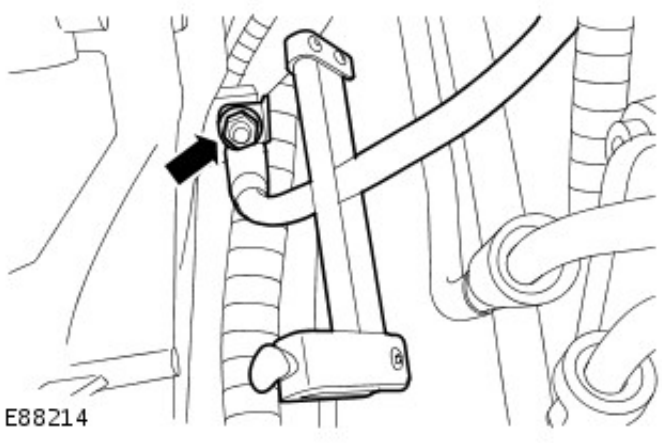
42. Release the transmission wiring harness securing clip from the RH side of the transmission.


E88218

43. Release the transmission wiring harness securing clip from the top of the transmission.

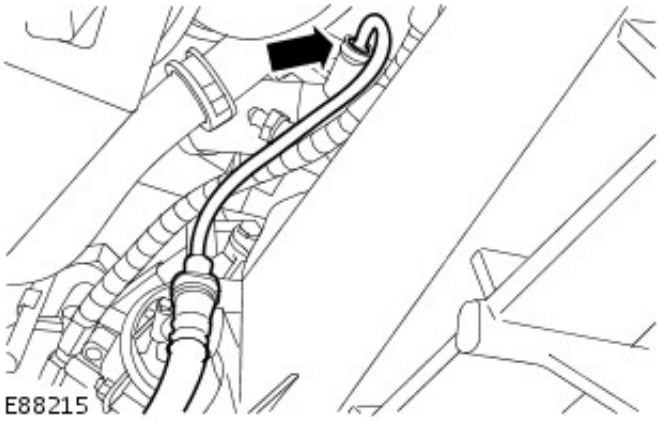

E88219

44. Remove the clutch slave cylinder fluid hose mounting



bracket securing nut and bolt.

- Install a suitable pipe clamp to the clutch slave cylinder fluid hose.

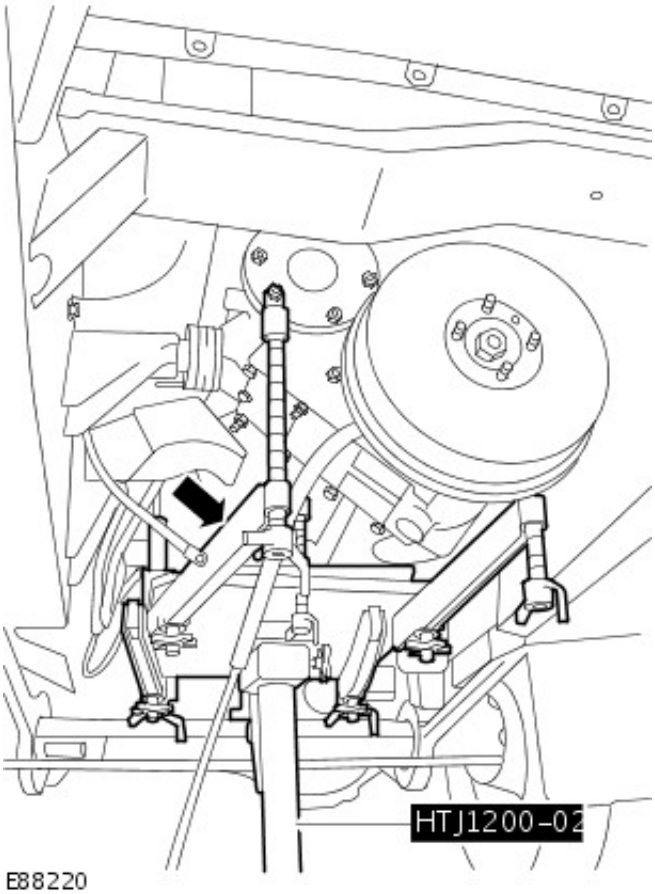


45. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the clutch slave cylinder fluid hose from the clutch slave cylinder.

- Remove the clutch slave cylinder line clip.
- Remove and discard the O-ring seal.

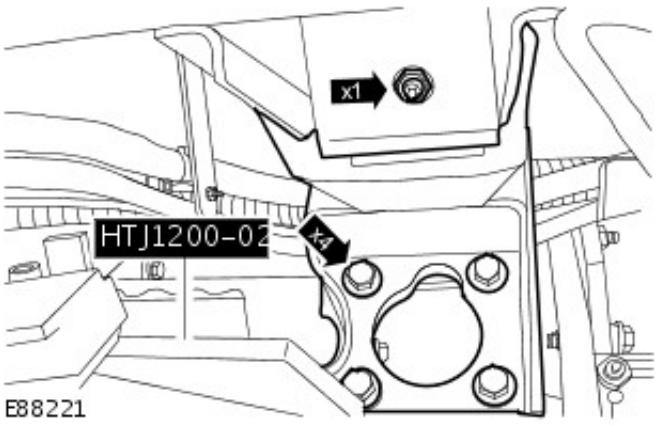
46. Install the special tool HTJ1200-02 to the transmission and transfer gearbox.



47. Remove the LH transmission mount and mounting

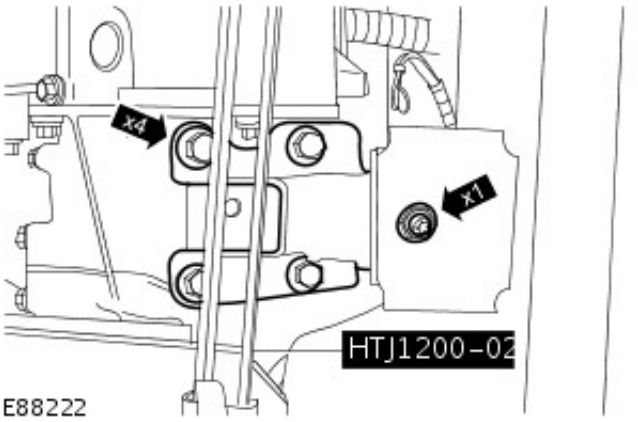
bracket.

- Remove the LH transmission mount and mounting bracket securing nuts and bolts.

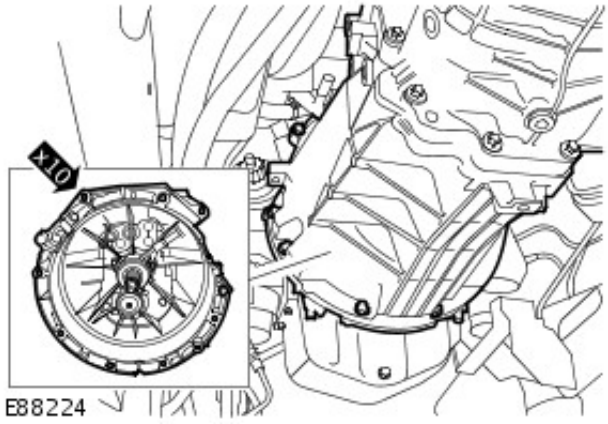


48. Remove the RH transfer gearbox mounting bracket.

- Remove the RH transfer gearbox mount and mounting bracket securing nuts and bolts.

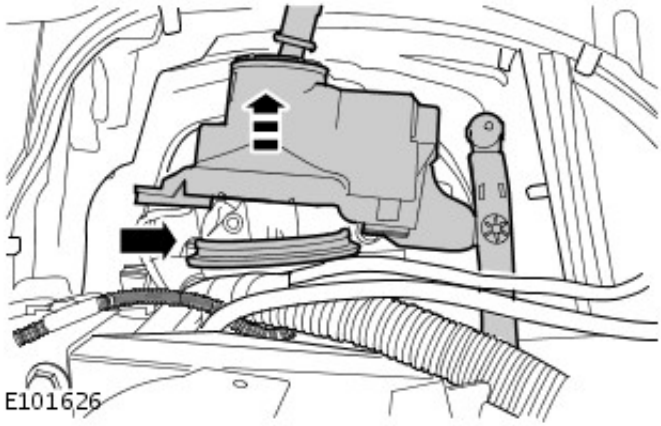


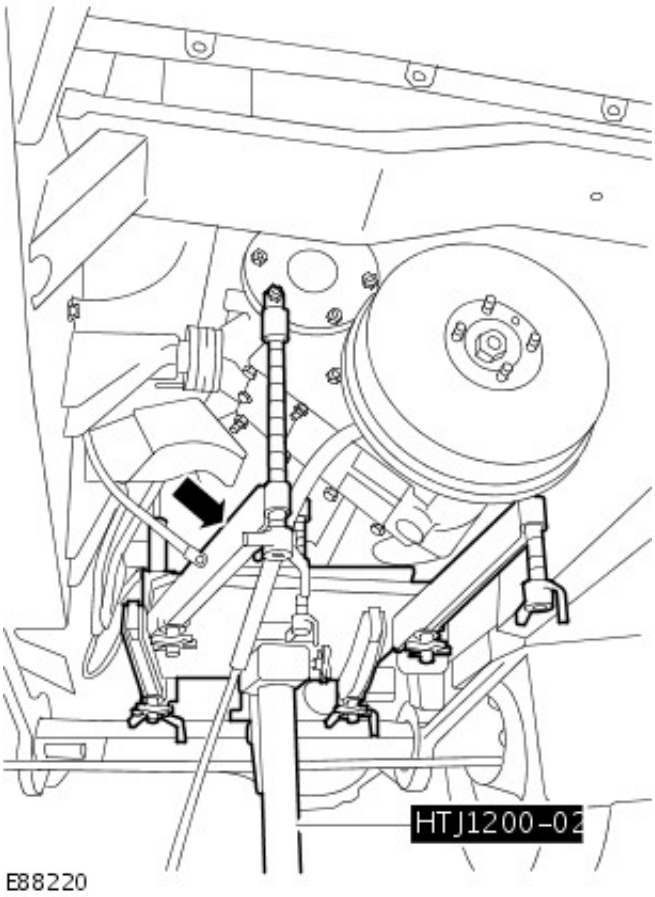
49. Remove the bell housing bolts.



50. Remove the gear selector housing.

- Reposition the transmission to allow access to the gear selector housing.
- Remove from below the vehicle.
- Remove the rubber seal.





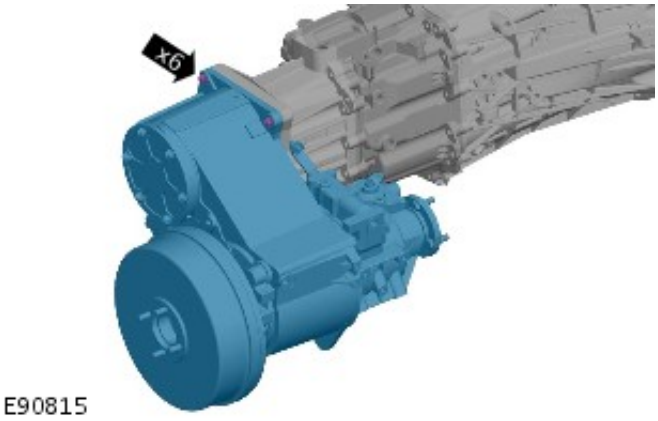
E88220

51. CAUTION: Disengage the transmission from the clutch by 30mm before lowering HTJ1200-02 to protect clutch from damage.

Remove the transmission and transfer gearbox from the vehicle.

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

Remove the transmission from the special tool.



E90815

53. With assistance, remove the transfer case.

- Remove the 4 bolts.
- Remove the 2 nuts.

54. Remove the transmission extension housing.

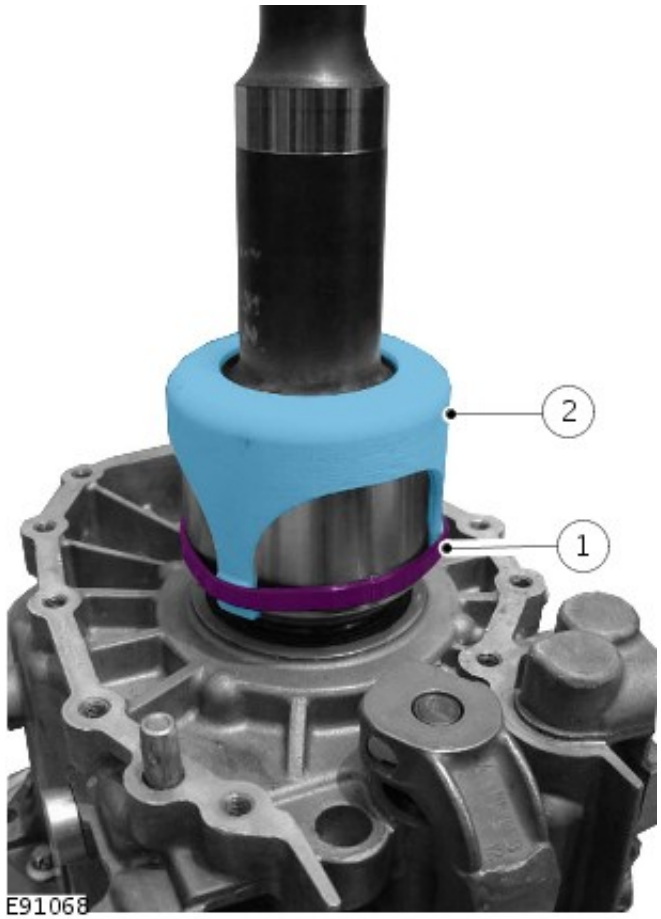
54. Remove the transmission extension housing.

- Remove the 10 bolts.

E91067

55. Remove the transmission extension shaft cover.

- Remove the tie strap.
- Remove the cover.

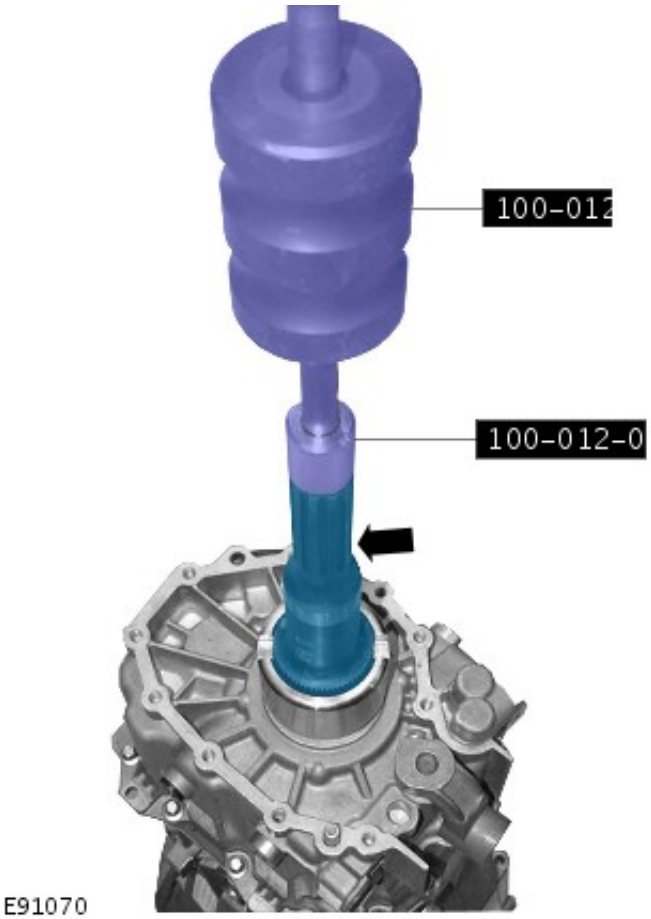


E91068

56. Remove the seal.

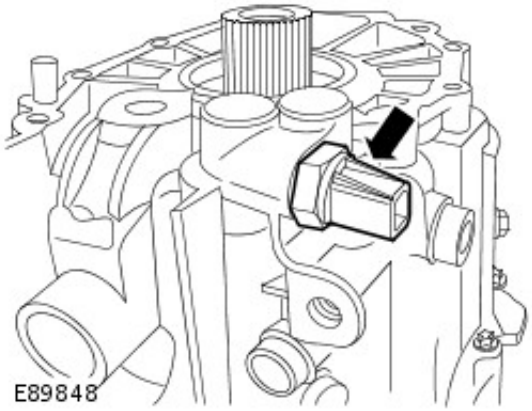
E91069

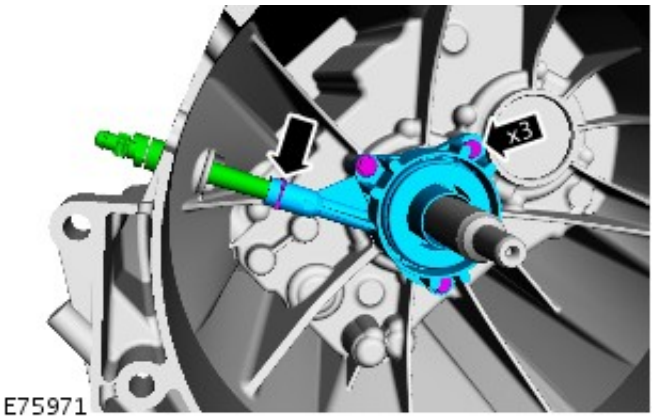
57. Using the special tools, remove the transmission extension shaft.



E91070

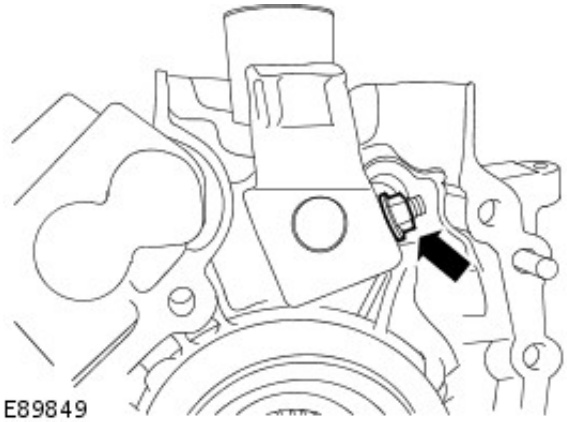
58. Remove the reversing lamp switch.



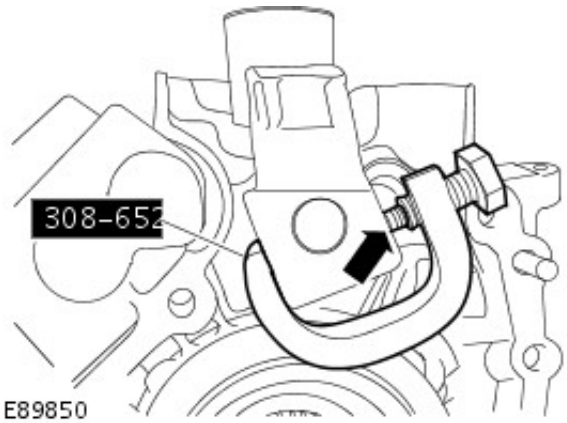


59. Remove the clutch slave cylinder.

- Remove the connecting pipe securing clip.
- Remove the connecting pipe.
- Remove the 3 bolts.



60. Remove the gearshift yoke securing nut.

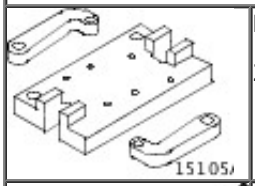
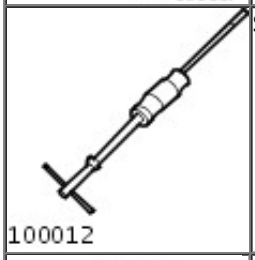
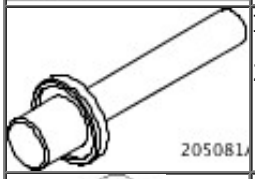
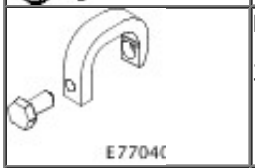
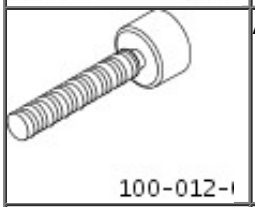


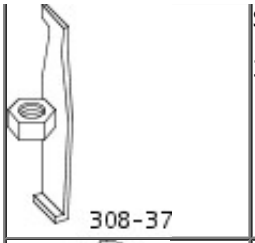
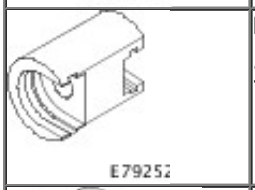
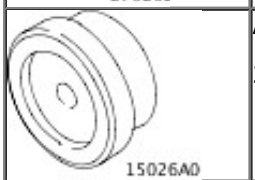
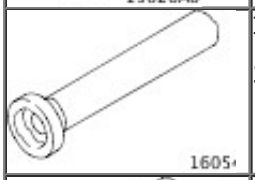
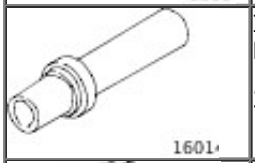
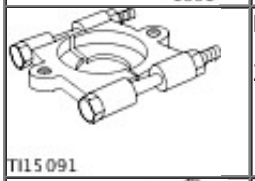
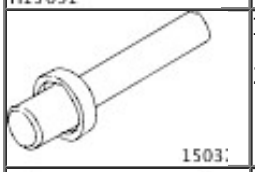
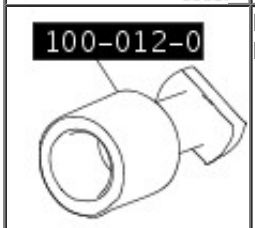
61. Using the special tool, remove the gearshift yoke.

- Remove the pin.

Manual Transmission/Transaxle - Transmission

Disassembly

Special Tool(s)	
	Mounting Bracket, Engine/Differential 205-329
 100012	Slide Hammer 100-012
 E52741	Remover Seals 308-615
 303-538	Rear Seal Remover/Replacer. 303-538
 E90665	Puller 308-516
	Installer 205-081A
	Remover Slider 308-652
 E52749	Remover Selector Shaft Seal 308-621
	Adaptor Slide Hammer 100-012-01

	Seal Remover Input & Output 308-375
	Remover, Detent 308-657
	Adapter for 205-071 (Thrust Pad) 205-071-01
	Installer, Mainshaft Double Lip Seal 308-150
	Installer, Transmission Extension Housing Bushing/Seal 308-044
	Remover, Bearing/Gear 205-310
	Installer, Differential Bearing 205-082
	Remover, Countershaft Bearing Outer Race 100-012-06
	Adapter, Slide Hammer 100-012-05
	Locking Tool, Output Flange 308-701

- NOTE: Make sure the positions of the transmission component are marked before removal.

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

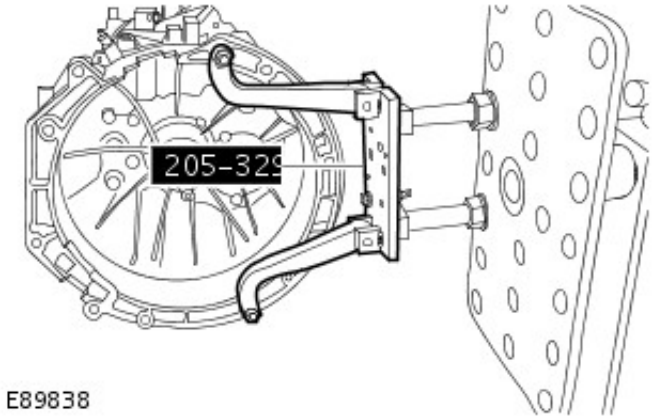
2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

3. Drain the transmission oil.
   For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

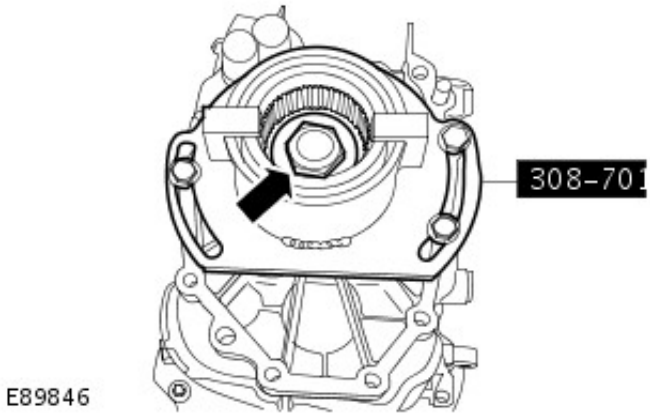
4. Remove the transmission.
   For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Removal).

5. Using the special tools, secure the transmission.



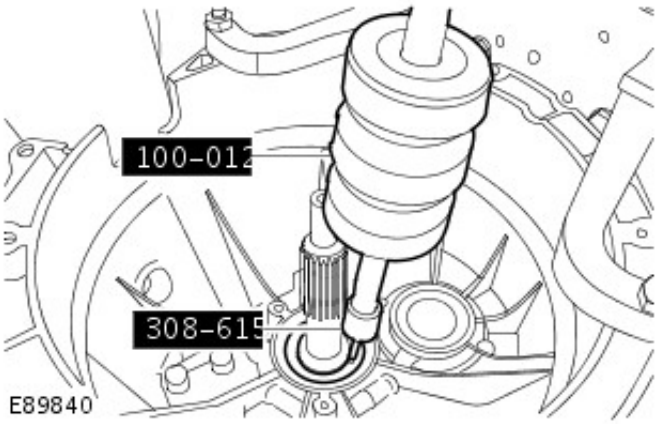
E89838

6. Using the special tool, lock the output shaft flange.
   - Remove the bolt.



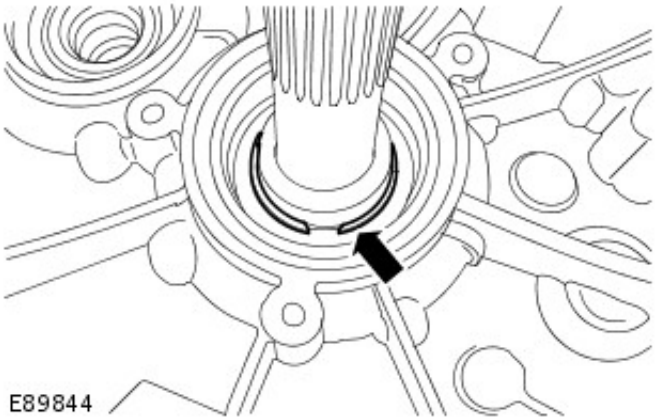
E89846

7. Using the special tools, remove and discard the input shaft seal.

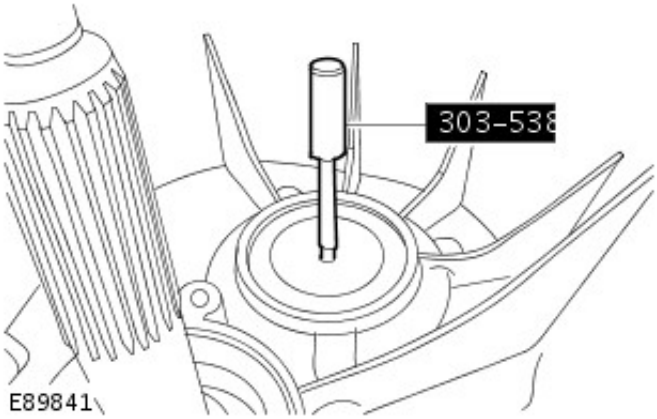


E89840

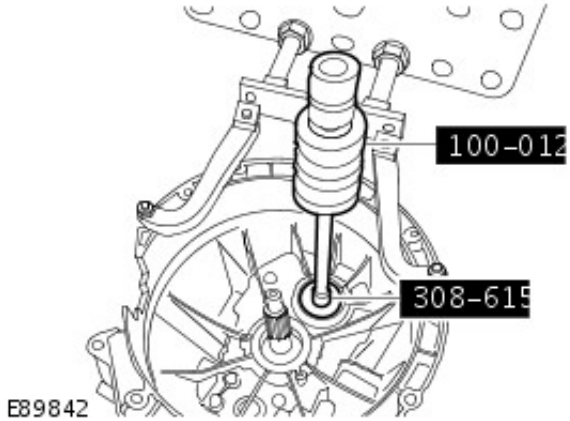
8. Remove and discard the input shaft snap ring.



9. Using the special tool, make a hole in the countershaft seal.

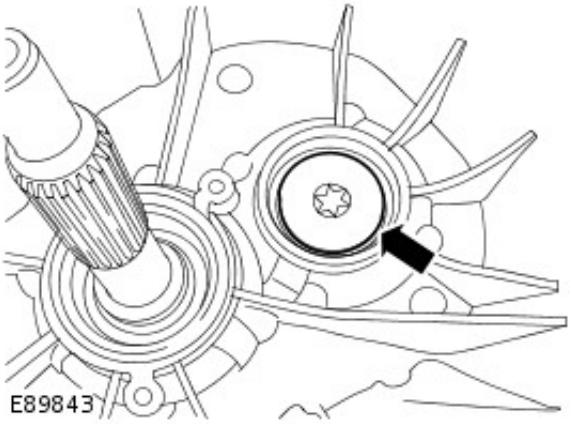


10. Using the special tools, remove and discard the countershaft seal.

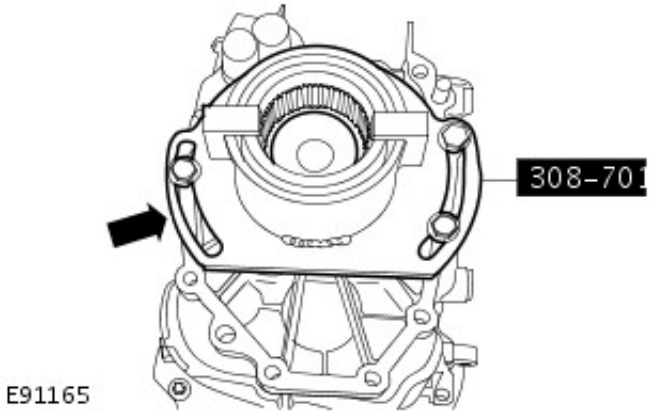


11. NOTE: Make sure that a gear is selected.

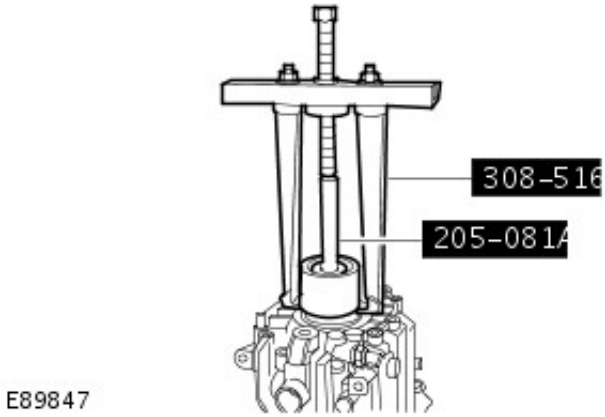
Remove the countershaft bolt.



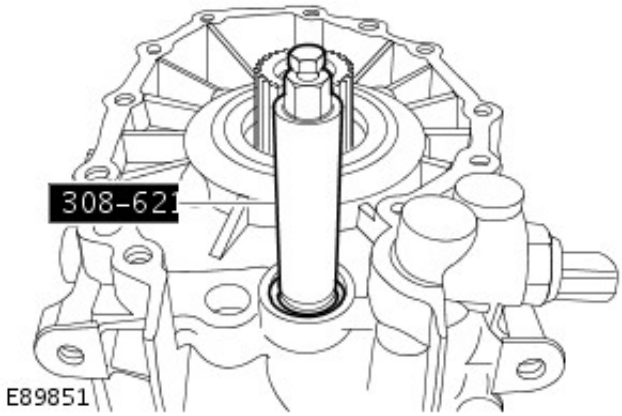
12. Remove the special tool.



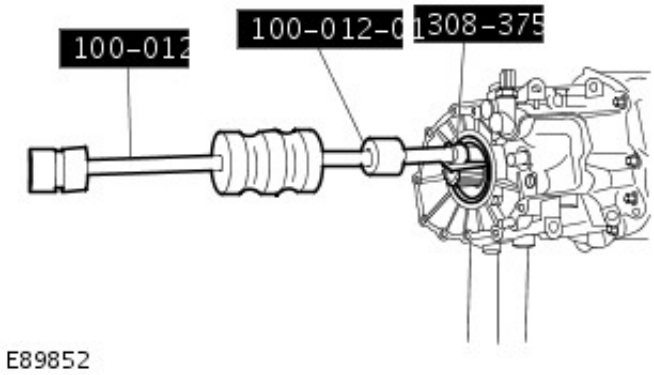
13. Using the special tools, remove the output shaft flange.



14. Using the special tool, remove the selector shaft seal.

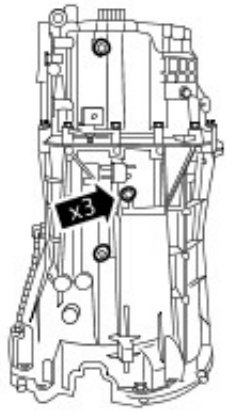


15. Using the special tools, remove the output shaft seal.



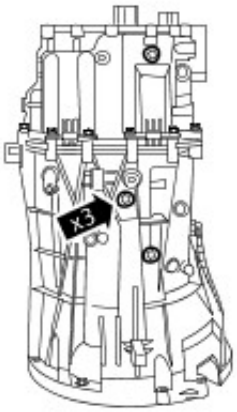
16. Remove the 3 LH selector fork bolts.

16. Remove the 3 LH selector fork bolts.



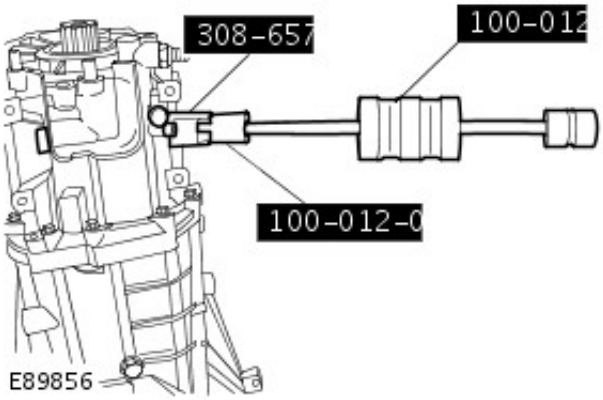
E89853

17. Remove the 3 RH selector fork bolts.



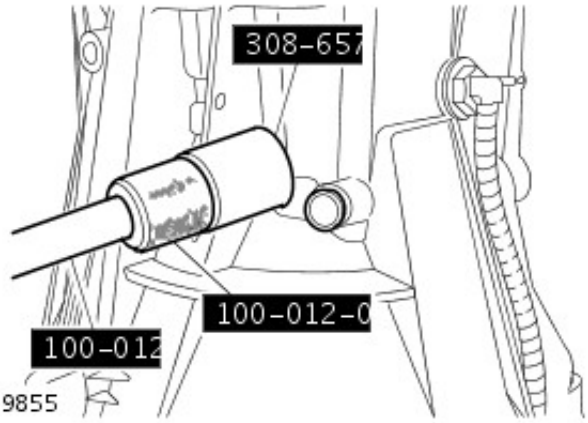
E89854

18. Using the special tools, remove the 3 selector shaft detents.



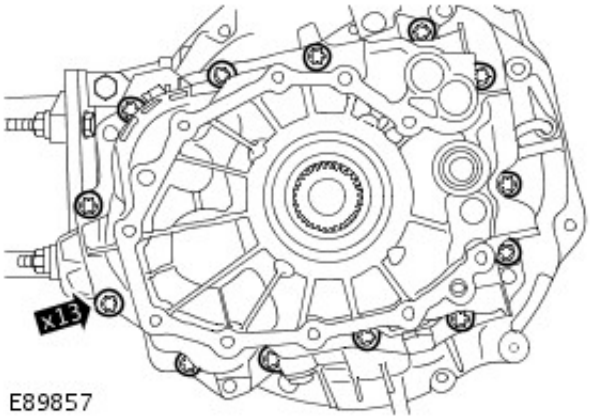
E89856

19. Remove the 2 selector shaft detents.



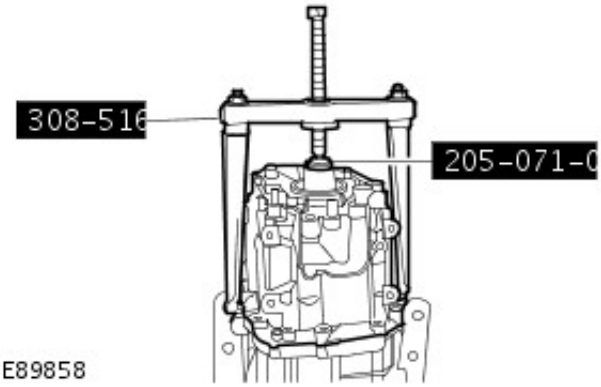
E89855

20. Remove the 13 bolts.



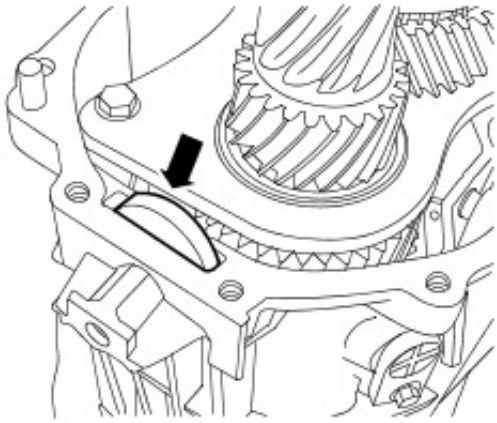
E89857

21. Using the special tools, remove the transmission housing.

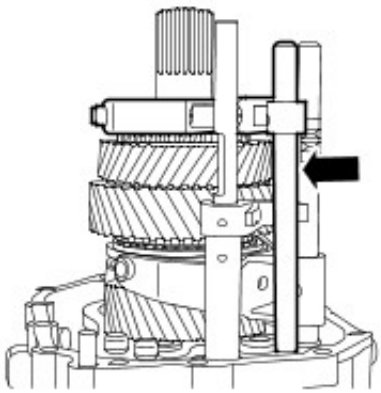


E89858

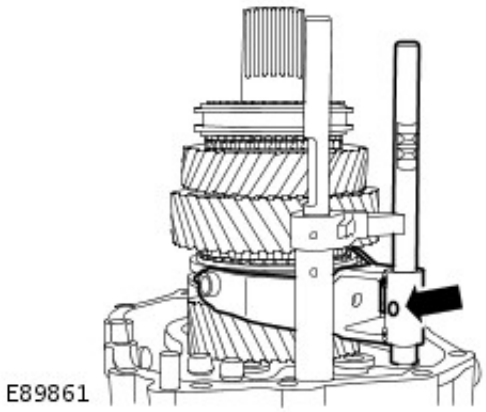
22. Remove the magnet.


E89859

23. Remove the reverse gear selector.

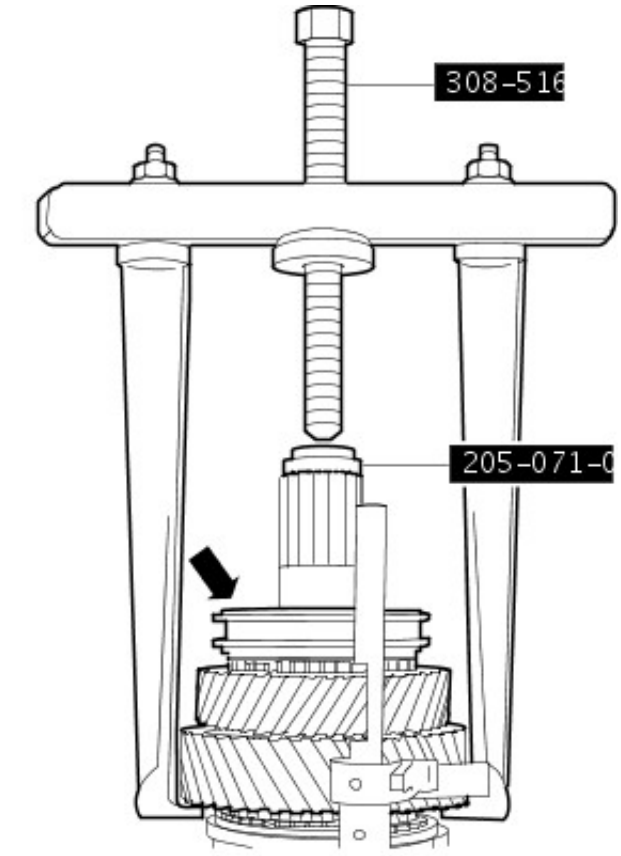

E89860

24. Remove the 1st/2nd gear selector.


E89861

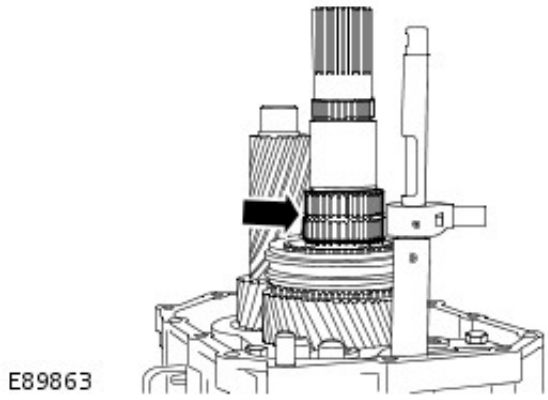
- Remove and discard the pin.

25. Using the special tools, remove the 1st and reverse gear assemblies from the output shaft.

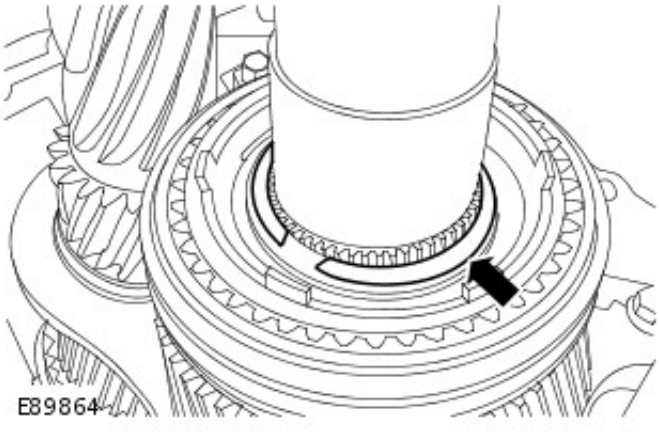


E89862

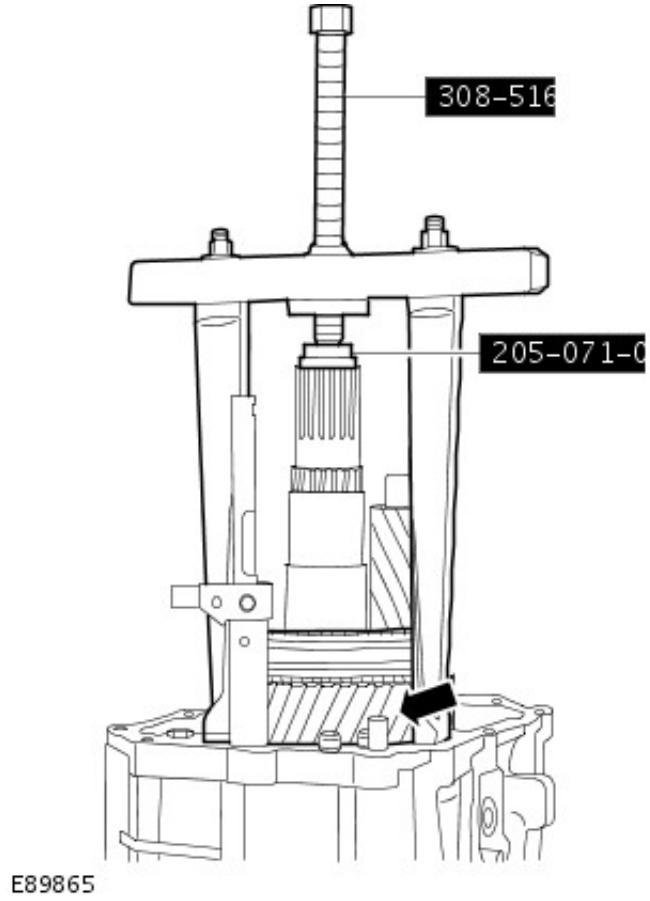
26. Remove the 1st gear bearing.


E89863

27. Remove the 1st/2nd gear synchronizer snap ring.

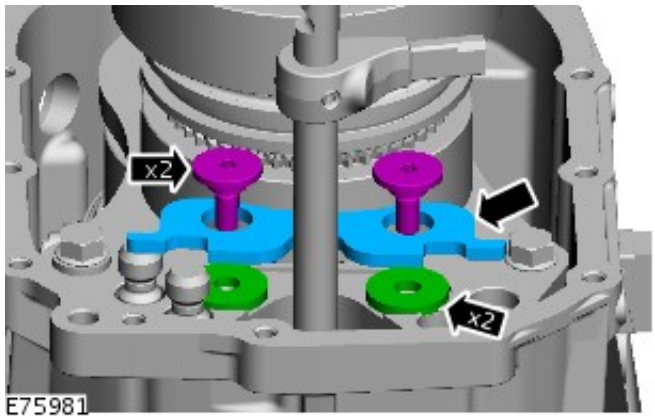


28. Using the special tools, remove the 2nd gear and 1st/2nd gear synchronizer assemblies from the output shaft.



29. Remove the selector shaft locking plate.

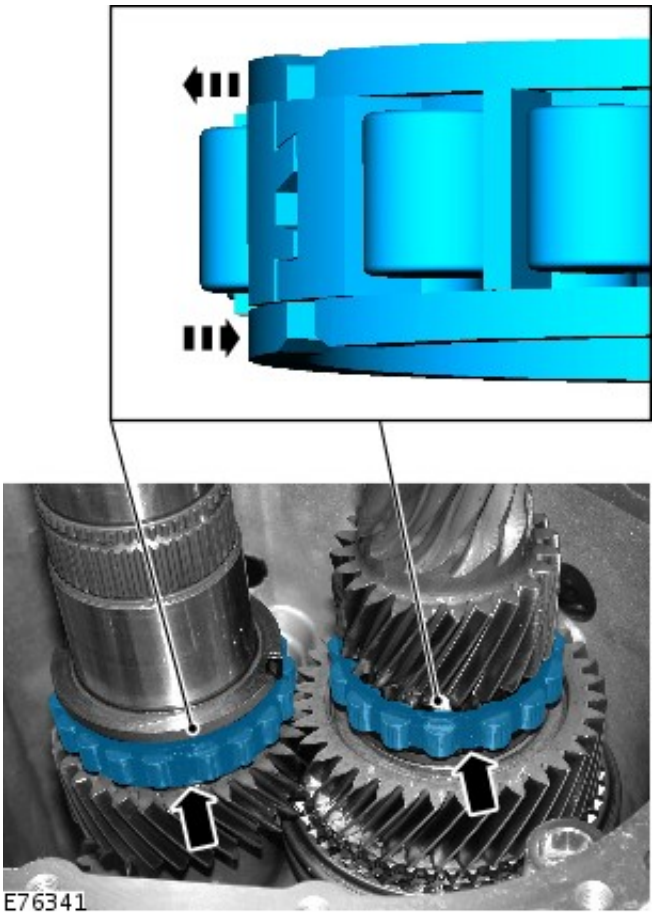
- Remove the 2 bolts.
- Remove the 2 spacers.



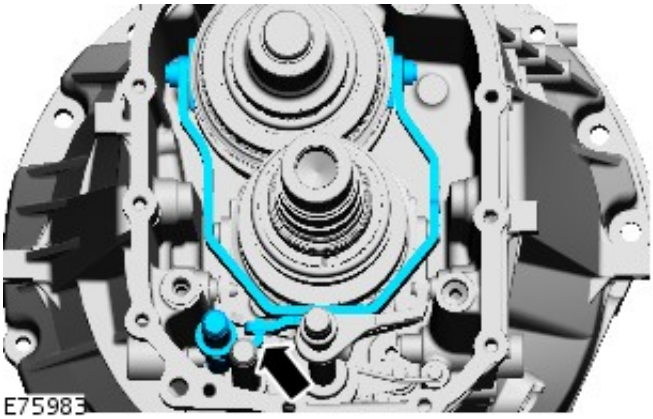
30. Remove the centre bearing mounting plate.

30. Remove the centre bearing mounting plate.

- Remove the 3 bolts.



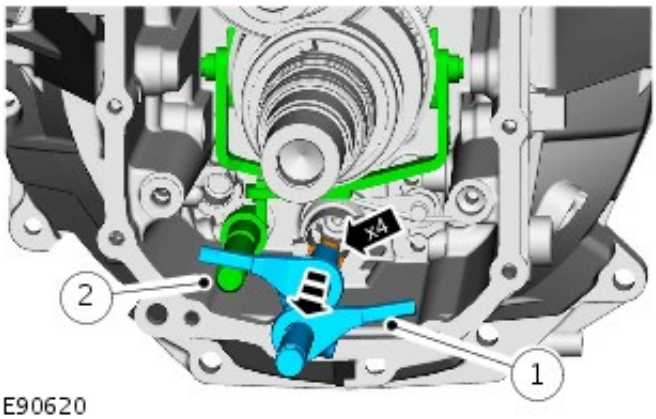
31. Remove the centre bearings.



32. Remove the 3rd/4th gear selector from the transmission housing.

- Release the selector fork from the selector shaft.

33. NOTE: Take care not to lose the 4 main selector shaft



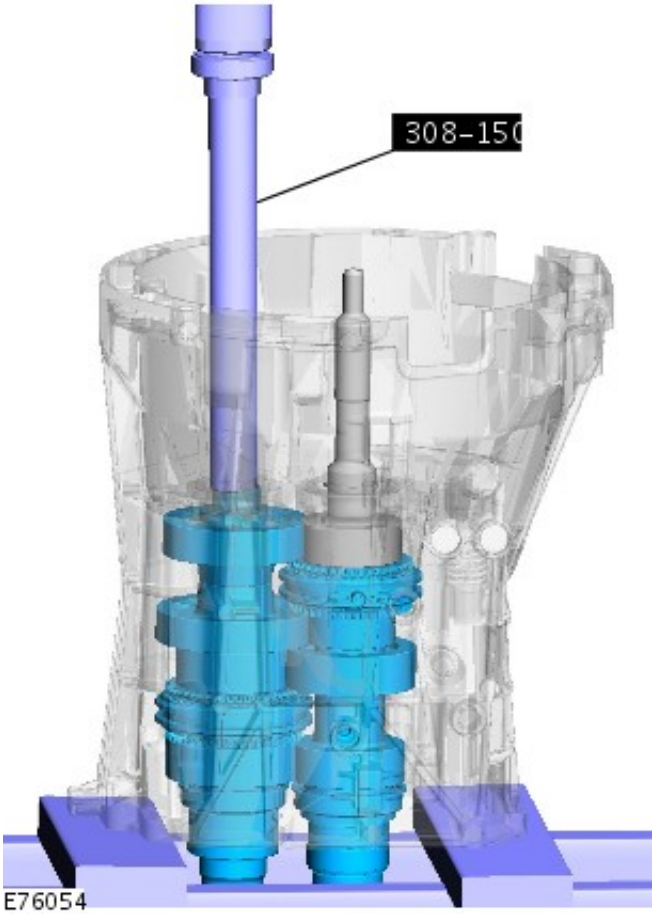
E90620

bearings.

Remove the selectors.

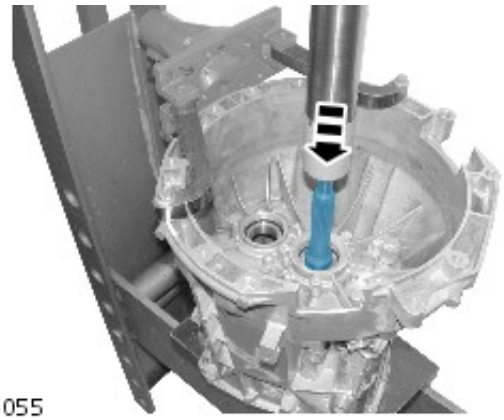
1. Remove the main selector.
2. Remove the 5th/6th selector.

34. With an assistant, remove the shaft assemblies.

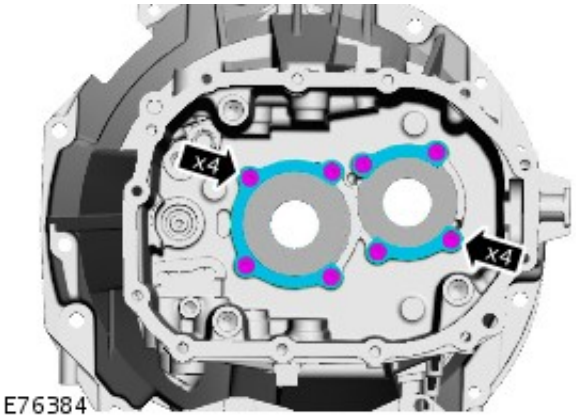


E76054

35. Remove the input shaft.

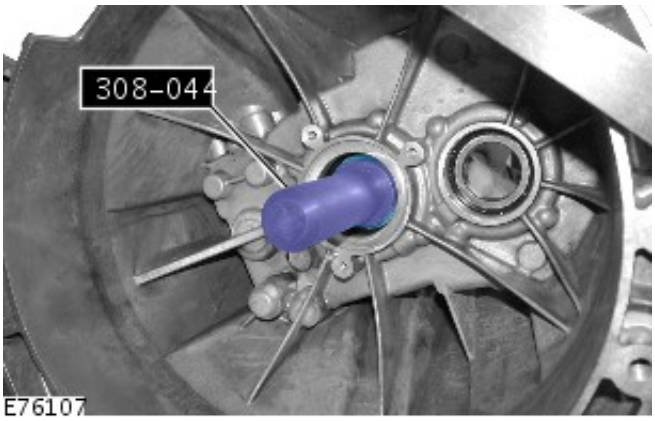

E76055

36. Remove the 2 bearing retaining plates.

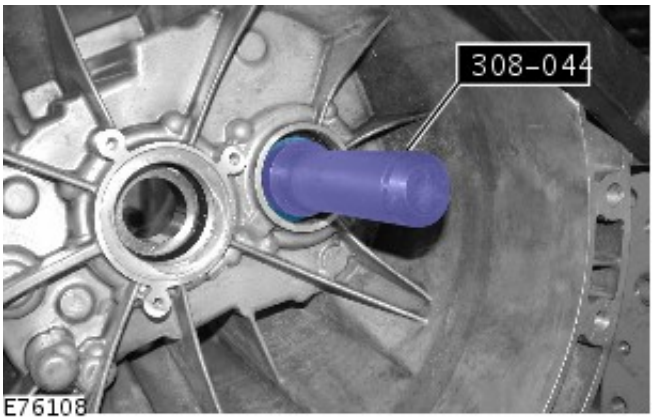


36. Remove the 2 bearing retaining plates.

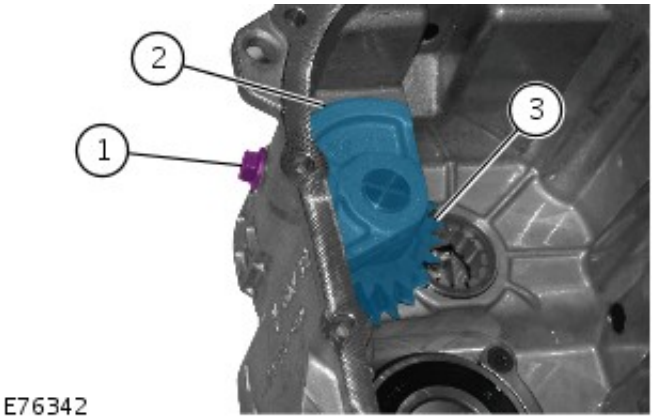
- Remove the 8 bolts.



37. Using the special tool, remove the input shaft bearing.



38. Using the special tool, remove the countershaft bearing.

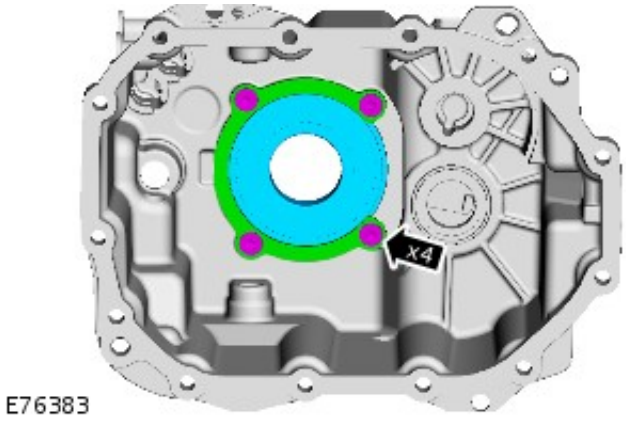


39. NOTE: Note the positions of the components on removal.

Remove the components in the sequence shown.

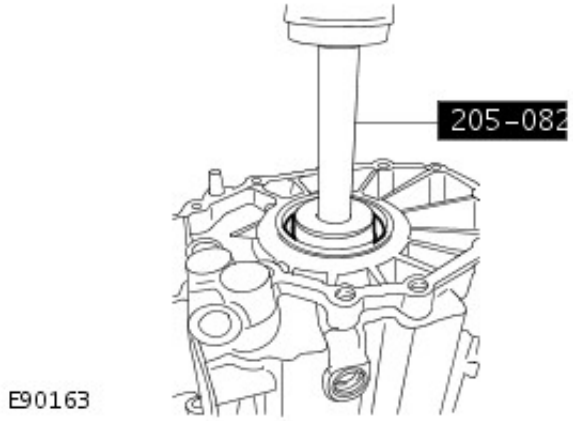
1. Reverse gear idler mounting bolt.
2. Reverse gear idler mounting.
3. Reverse gear idler.
4. Countershaft roller bearing.

40. Remove the output shaft bearing retaining plate.

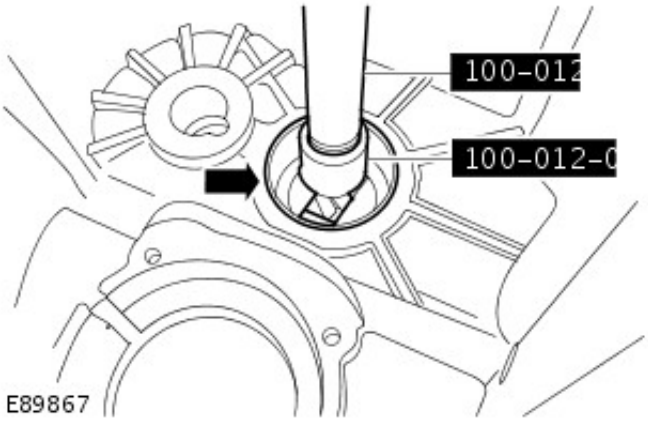


- Remove the 4 bolts.

41. Using the special tool, remove the output shaft bearing.

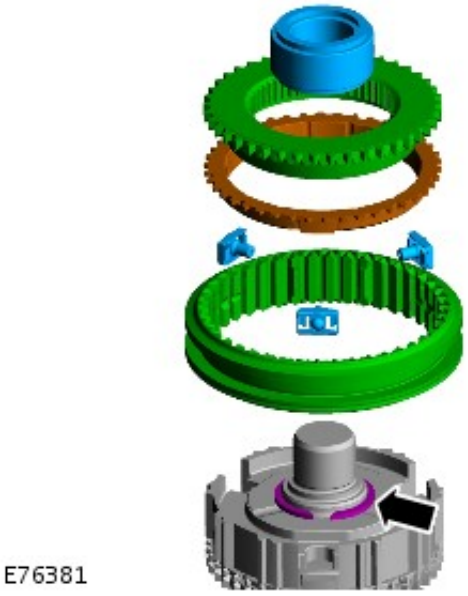


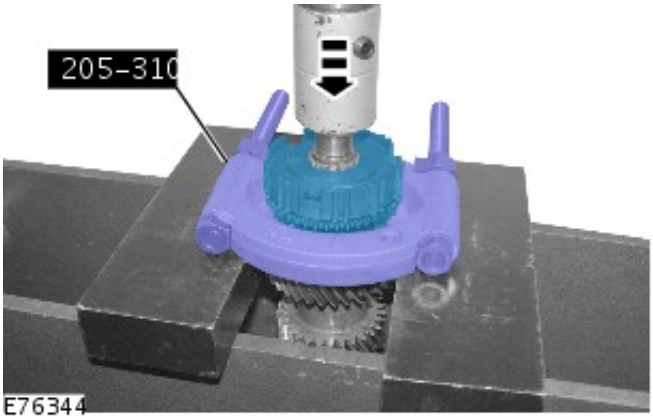
42. Using the special tools, remove the countershaft bearing outer race.



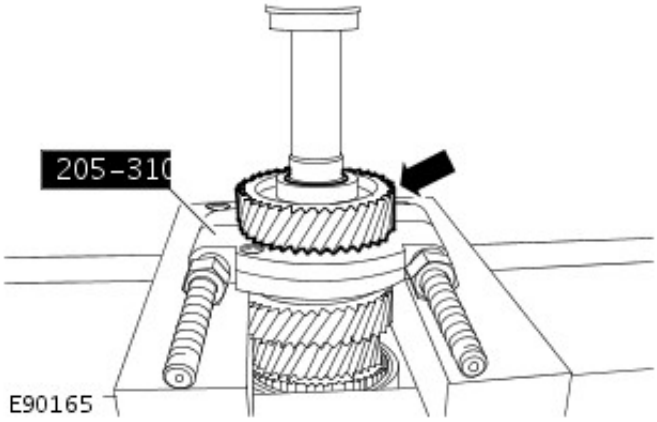
43. Remove the output shaft pilot bearing and the 5th gear synchronizer assembly from the output shaft.

- Remove and discard the snap ring.

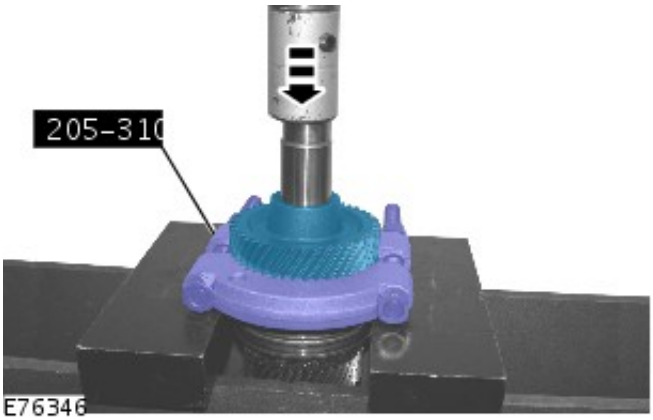




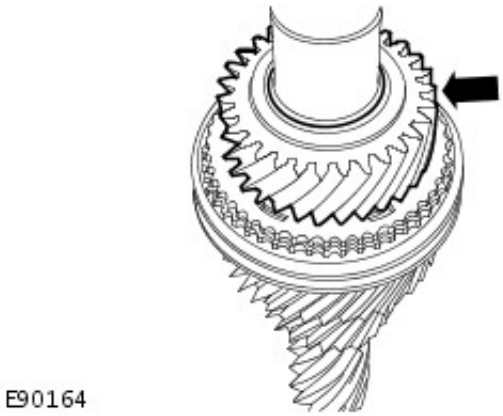
44. Using the special tool, remove the 6th gear synchronizer/hub assembly from the output shaft.



45. Using the special tool, remove the 5th gear from the countershaft.



46. Using the special tool, remove the 6th gear from the countershaft.



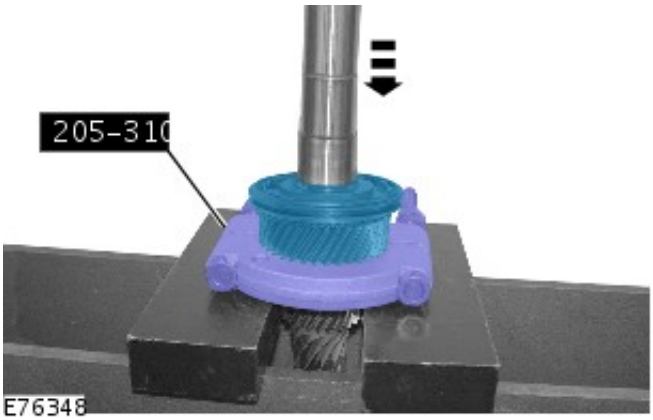
47. Remove the 3rd gear from the countershaft.

48. Remove the 3rd/4th gear synchronizer snap ring from the

countershaft.

E76347

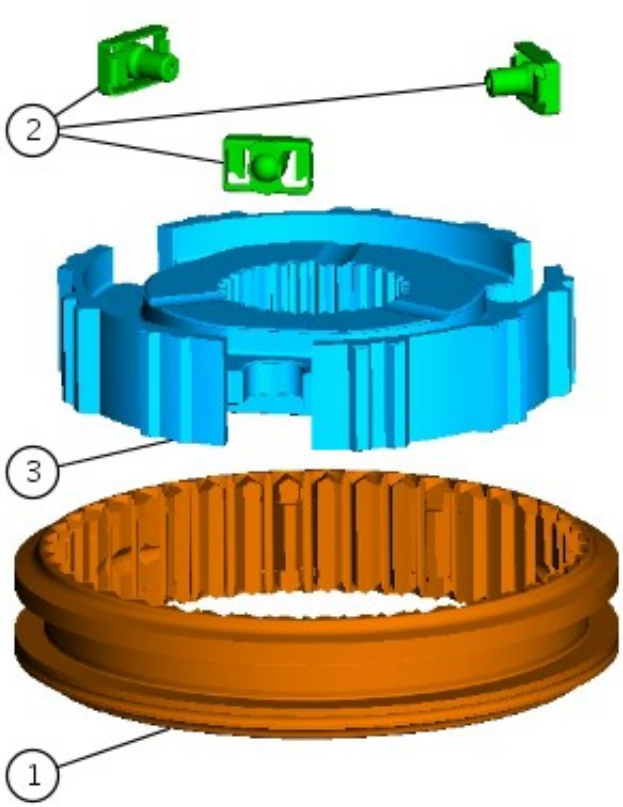
49. Using the special tool, remove the 4th gear and synchronizer assembly from the countershaft.



E76348

Manual Transmission/Transaxle - Synchronizers

Disassembly and Assembly of Subassemblies



E80427

Disassembly

1. NOTE: Make a note of/mark the installed positions of the components before removal.

1. Sliding collar.
2. Sliding block assemblies.
3. Synchronizer hub.

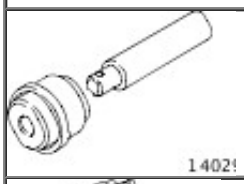
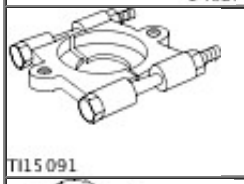
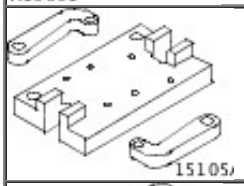
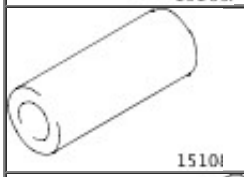
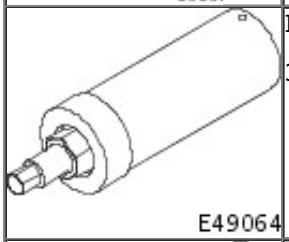
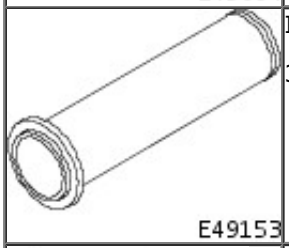
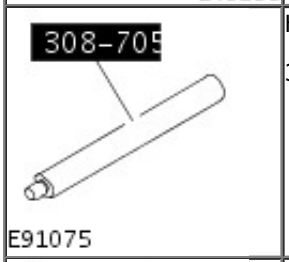
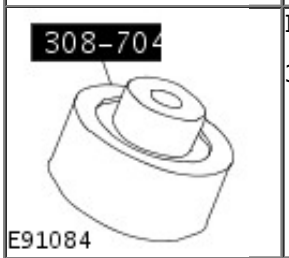
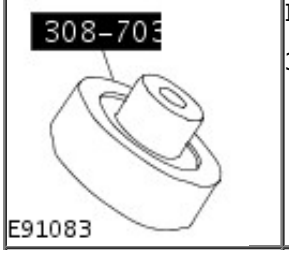
Assembly

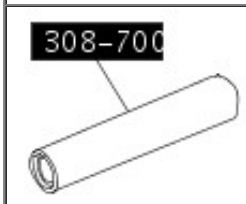
1. NOTE: Make sure that the components are installed in their original positions.

To install, reverse the removal procedure.

Manual Transmission/Transaxle - Transmission

Assembly

Special Tool(s)	
	Installer, Front Wheel Hub Bearing Cup/Seal 204-087
	Remover, Bearing/Gear 205-310
	Mounting Bracket, Engine/Differential 205-329
	Protector, Axle Shaft 205-332
	Installer, Output Drive Flange Seal 308-604
	Installer, Input Shaft Seal 308-605
	Handle, Bearing Installer 308-705
	Installer, Countershaft Bearing 308-704
	Installer, Input Shaft Bearing 308-703

E91081	Installer, Output Shaft Bearing 308-702
 E91078	Installer, Selector Shaft Seal 308-700

General Equipment
Tie Straps
Hot air gun
Hydraulic press

Materials

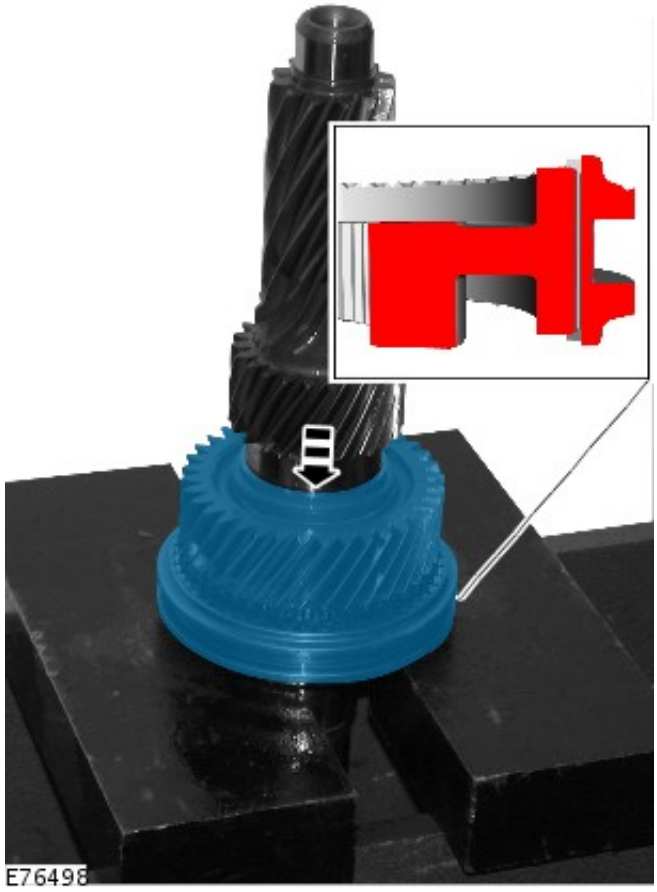
Name	Specification
Transmission Fluid	WSD-M2C200-C
High-Temperature Grease	ESD-M1C220-A
Gasket Eliminator Sealant	WSK-M2G348-A5
Adhesive - Loctite 243	WSK-M2G349-A7

Assembly

1. NOTE: All synchronizer rings and needle bearings should be lubricated with clean transmission fluid prior to assembly.

transmission fluid

2. Install the 4th gear and 3rd/4th gear synchronizer assembly onto the countershaft.


E76498

3. Install the 3rd/4th gear synchronizer assembly snap ring onto the countershaft.

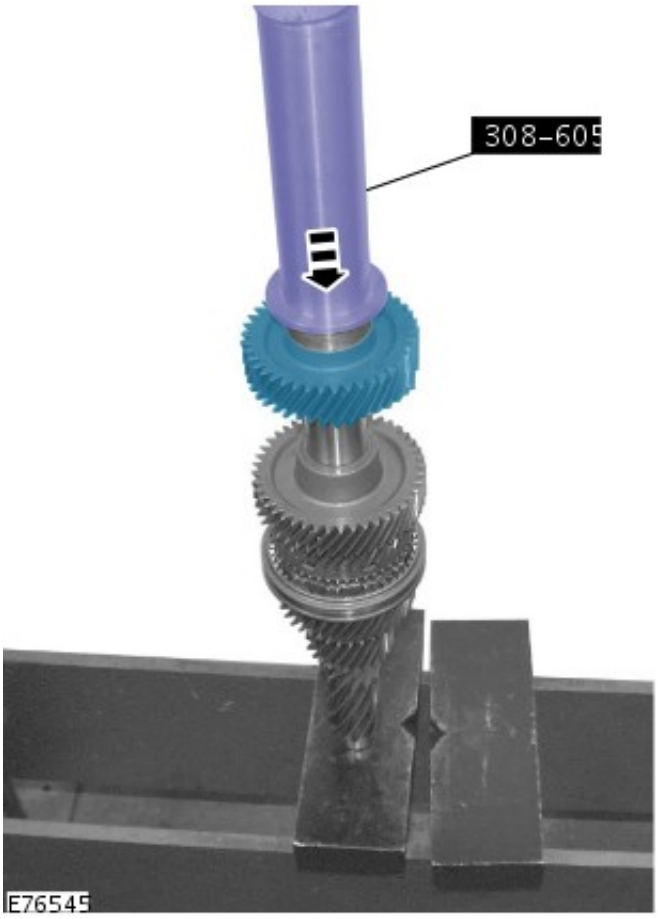
E76347

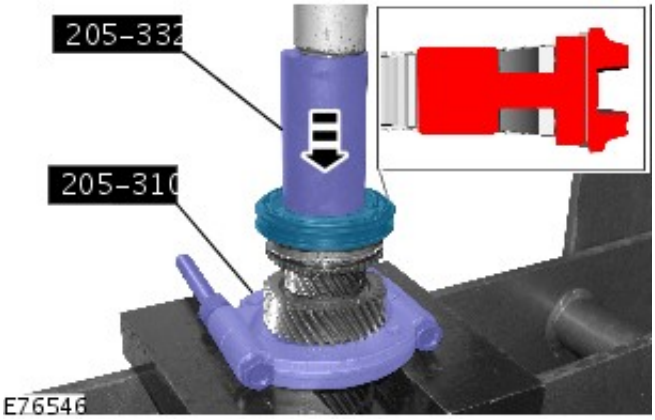
- Install a new snap ring.

E76499

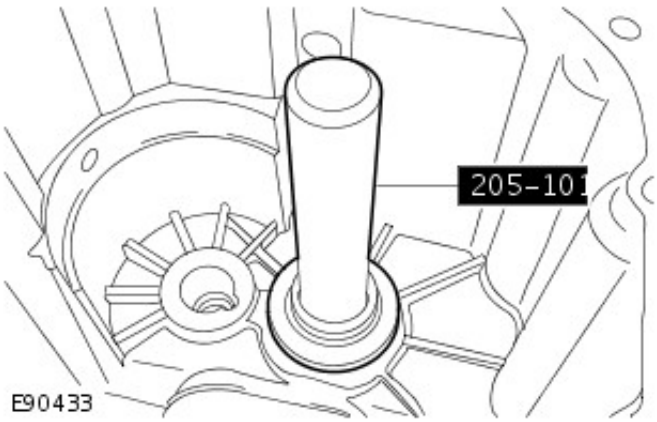
4. Using the special tool, install the 6th gear onto the countershaft.

5. Using the special tool, install the 5th gear.





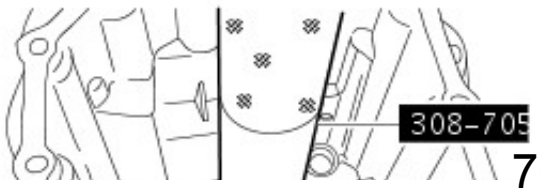
6. Using the special tools, install the 5th/6th gear synchroniser assembly onto the output shaft.



7. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

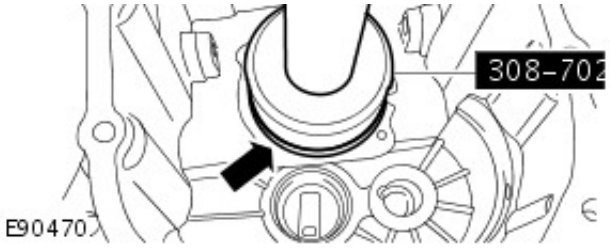
• NOTE: Heat the transmission housing to approx 100 °C (212 °F) using a hot air gun.

Using the special tool, install the countershaft outer bearing race into the transmission housing.



8. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

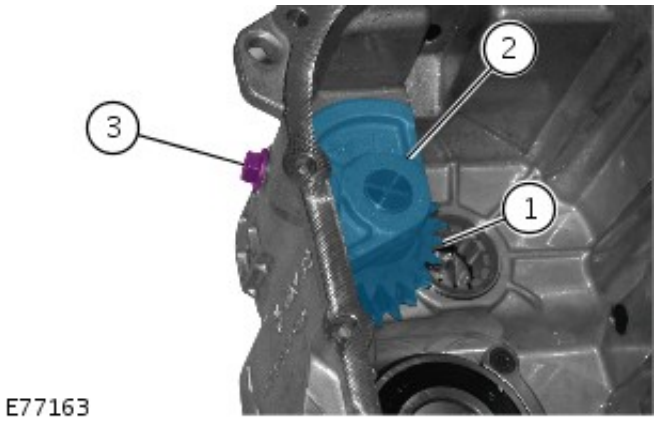
• NOTE: Heat the transmission housing to approx 100 °C (212 °F) using a hot air gun.



Using the special tool, install the output shaft bearing.

9. Install the output shaft bearing retaining plate.

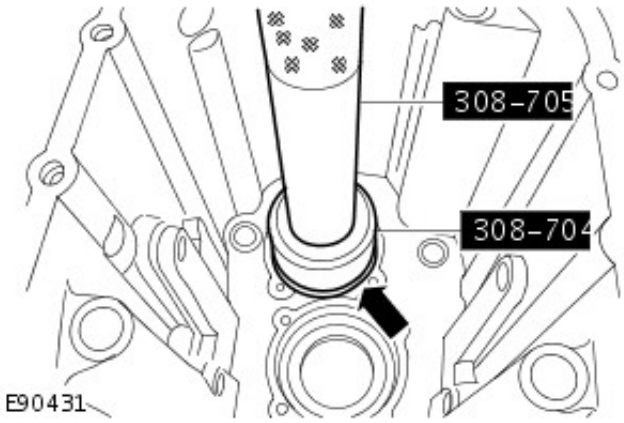
- Tighten the bolts to 10 Nm (7 lb.ft).



10. NOTE: Install the components in the positions noted on removal.

Install the components into the transmission housing using the following sequence.

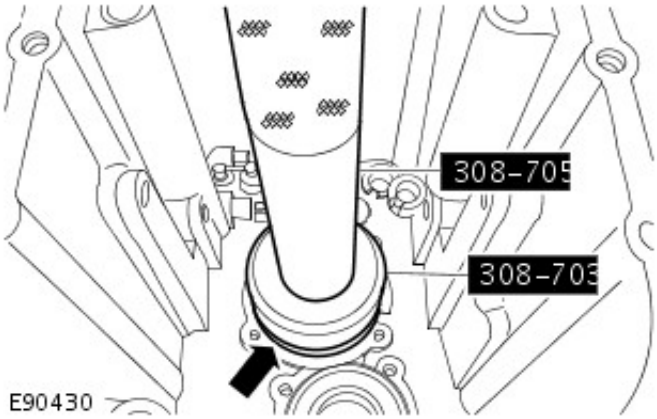
1. Countershaft roller bearing.
2. Reverse gear idler.
3. Reverse gear idler mounting.
4. Tighten the bolt to 27 Nm (20 lb.ft).



11. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

• NOTE: Heat the transmission housing to approx 100 °C (212 °F) using a hot air gun.

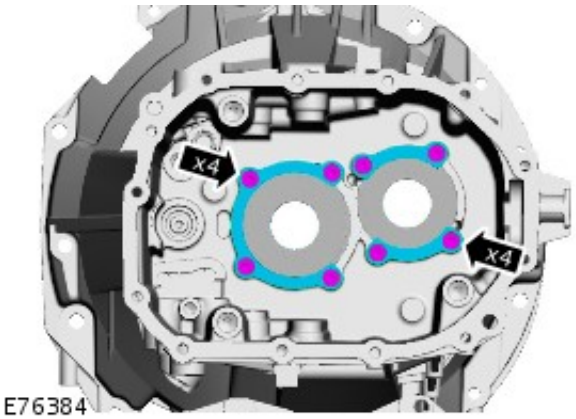
Using the special tool, install the countershaft bearing.



12. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

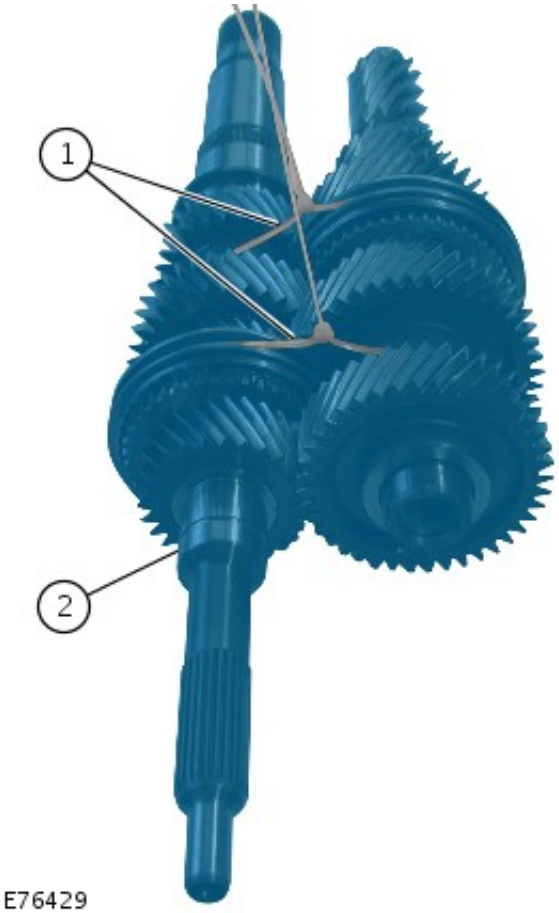
• NOTE: Heat the transmission housing to approx 100 °C (212 °F) using a hot air gun.

Using the special tool, install the input shaft bearing.



13. Install the bearing retaining plates.

- Tighten the bolts to 10 Nm (7 lb.ft).



14. Secure the shaft assemblies together.

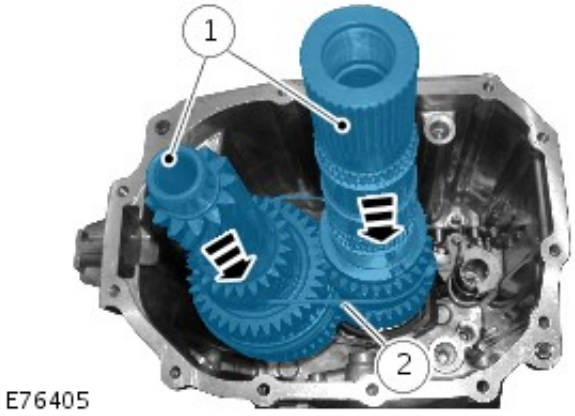
1. Use suitable tie straps at the positions shown.
2. Make sure the input shaft does not become detached.

15. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

• NOTE: Heat up the special tools with a hot air gun to around 100 °C and then transfer them to the bearings.

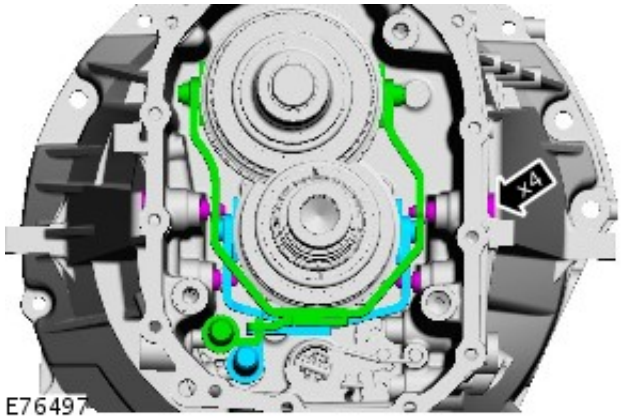
Using the special tools, apply heat to the bearing centre

races.



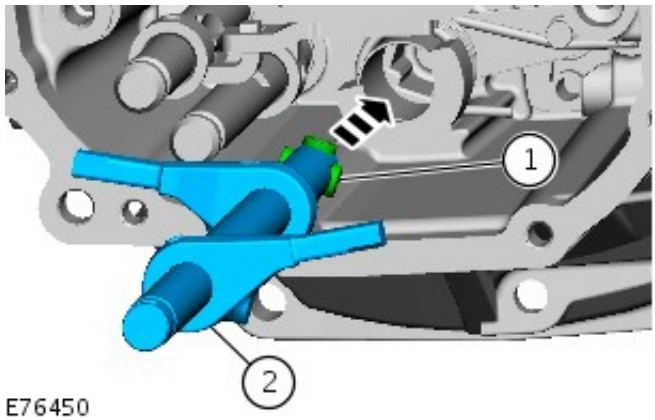
16. Install the output shaft and countershaft assemblies.

- Remove and discard the tie straps.



17. Install the 3rd/4th and 5th/6th gear selectors.

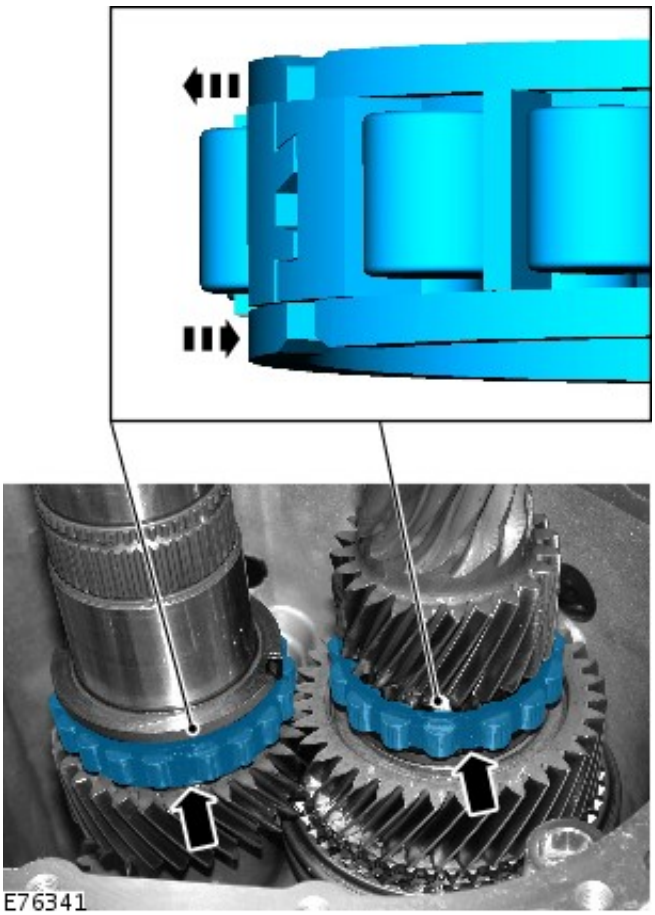
- Tighten the bolts to 37 Nm (27 lb.ft).



18. Install the main selector.

1. Secure the bearings with grease.grease
2. Install the main selector.

19. Install the centre bearings.

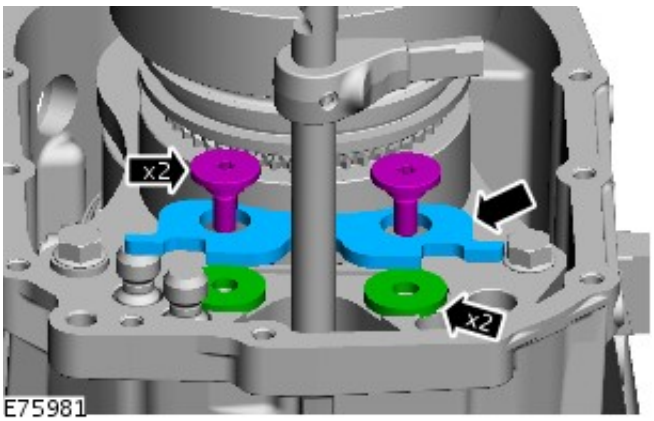


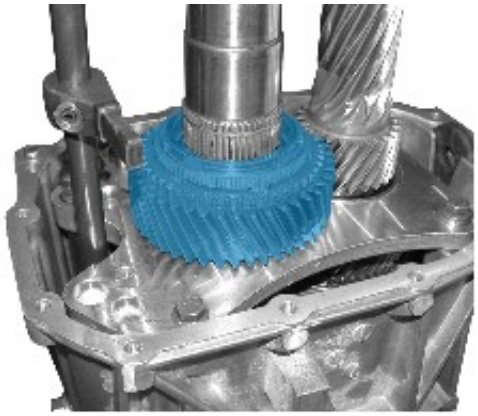
20. Install the centre bearing mounting plate.

- Tighten the bolts to 24 Nm (18 lb.ft).

21. Install the selector shaft locking plate.

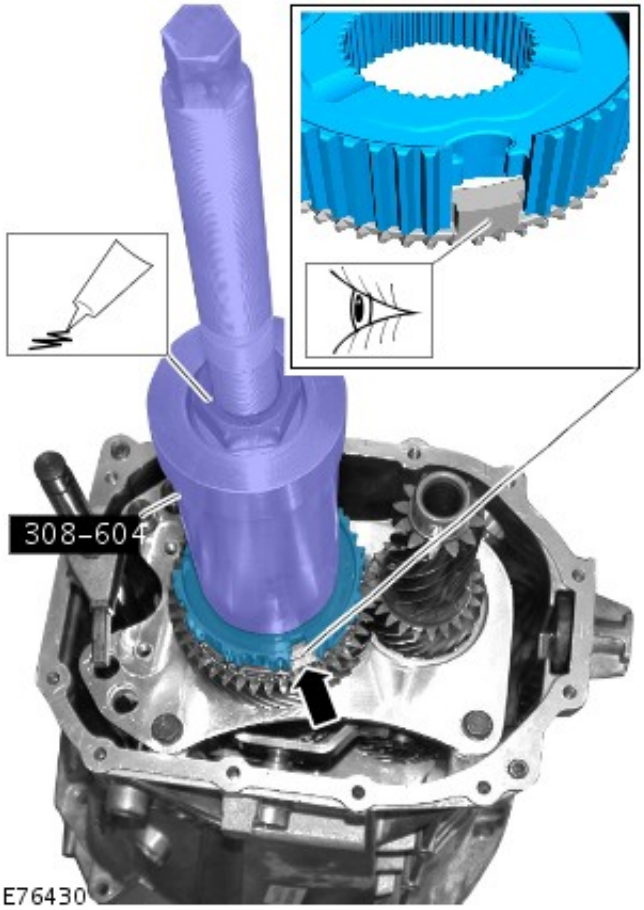
- Install the spacers.
- Tighten the bolts to 24 Nm (18 lb.ft).





E76441

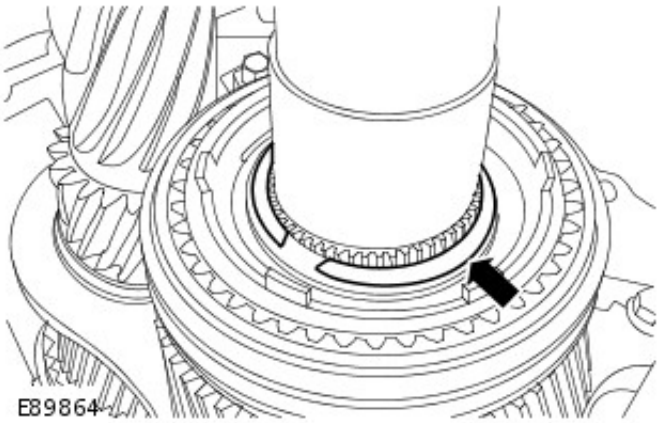
23. Using the special tools, install the 1st/2nd gear synchronizer assembly onto the output shaft.



E76430

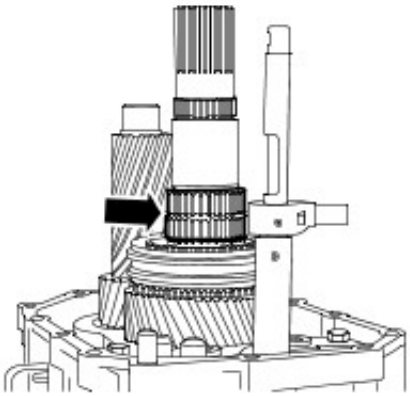
24. Install the 1st/2nd gear synchronizer snap ring.

- Install a new snap ring.



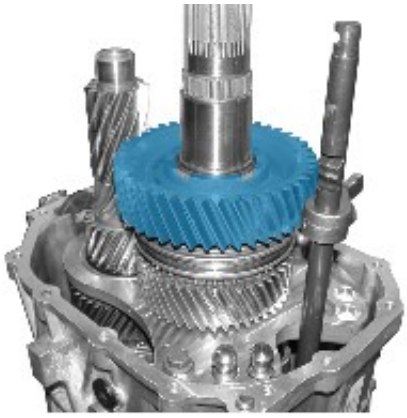
E89864

25. Install the 1st gear needle roller bearing.



E89863

26. Install the 1st gear.

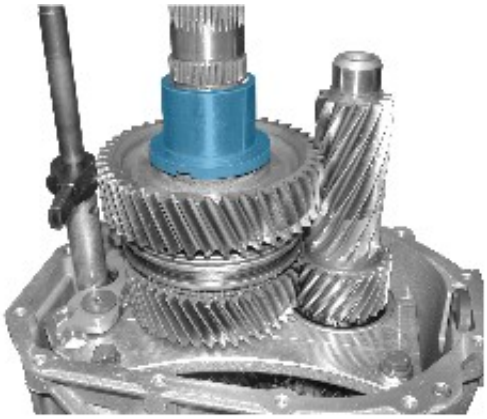


E76431

27. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

• NOTE: Heat the reverse gear inner bearing race to approx 100 °C using a hot air gun.

Install the reverse gear inner bearing race.



E76547

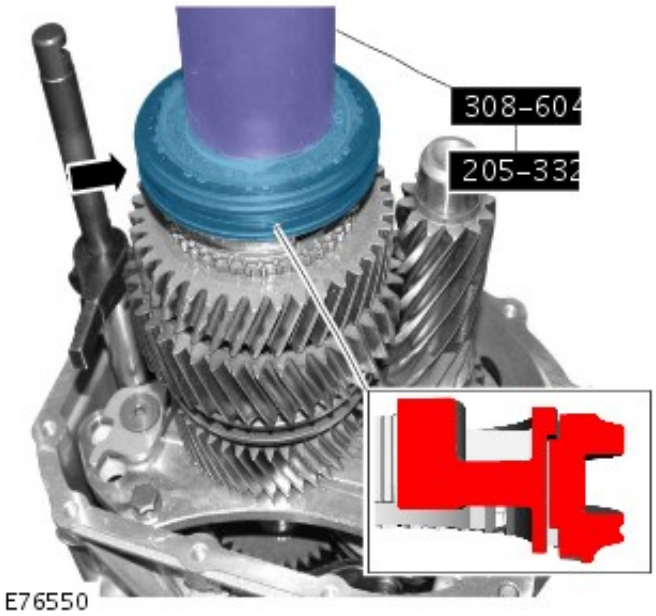
28. Install the reverse gear needle roller bearing.

E76548

29. Install the reverse gear onto the output shaft.

E76549

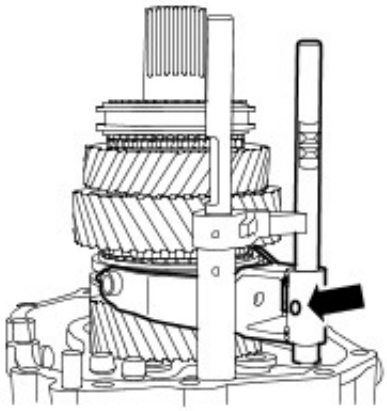
30. Using the special tool, install the reverse gear synchroniser onto the output shaft.



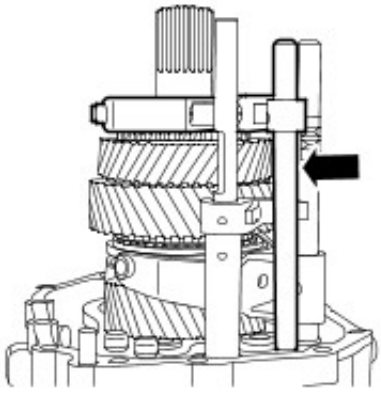
E76550

31. Install the 1st/2nd gear selector.

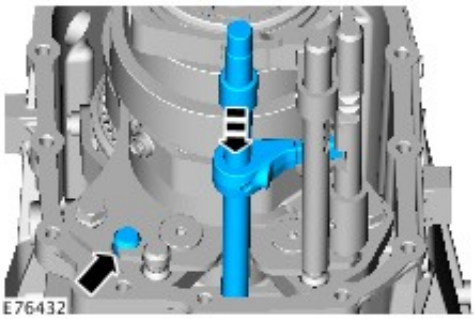
- Install a new pin.


E89861

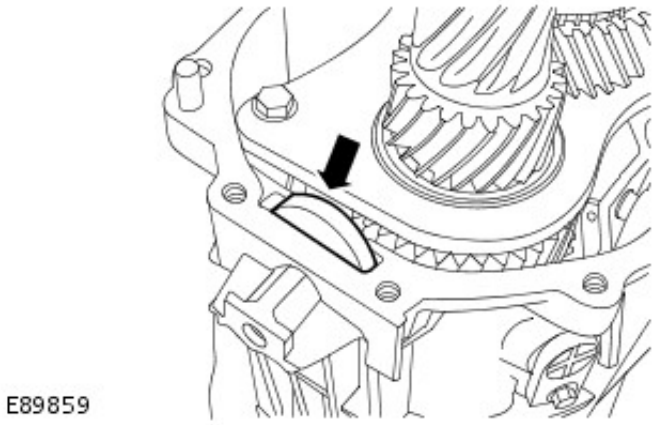
32. Install the reverse gear selector.


E89860

33. Select a gear.



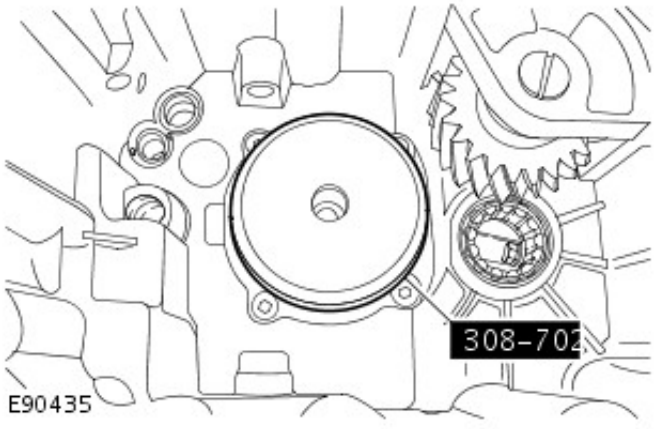
34. Install the magnet.



35. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

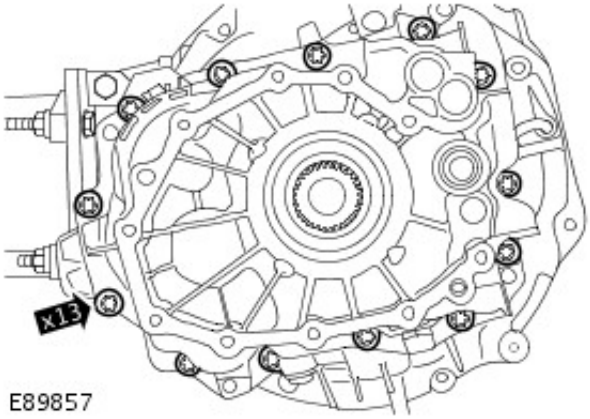
• NOTE: Heat up the special tool with a hot air gun to around 100 °C and then transfer it to the bearing.

Using the special tool, apply heat to the bearing inner race.

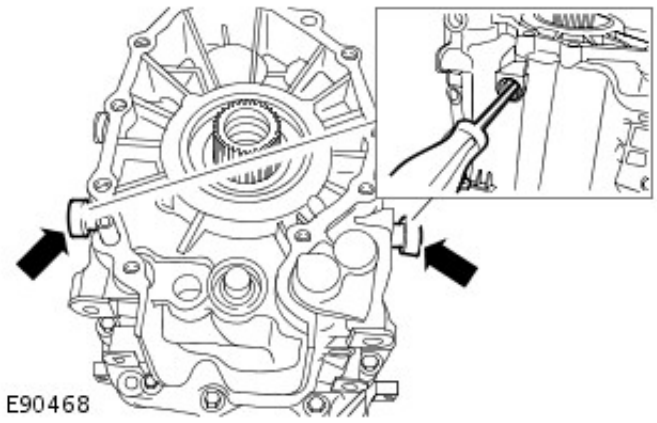


36. Install the transmission housing.

- Apply sealant to the mating surfaces.sealant
- Loosely install the transmission housing bolts.

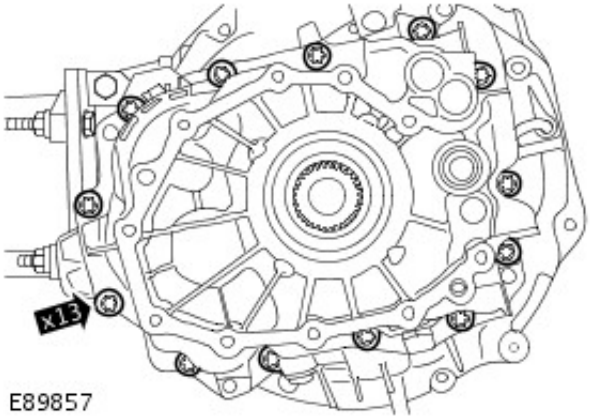


37. Install the reverse gear selector fork mounting bolts.



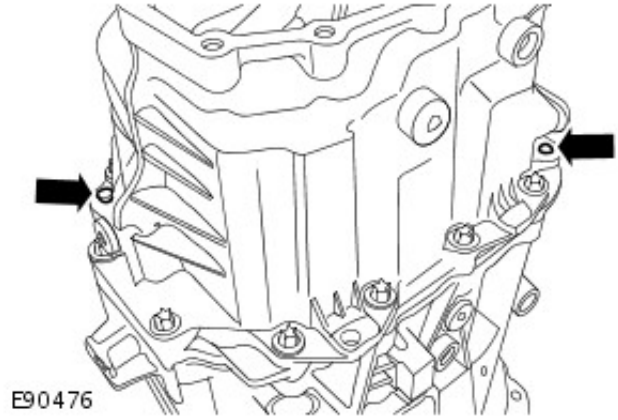
- Align the selector fork.
- Tighten to 37 Nm (27 lb.ft).

38. Tighten the transmission housing bolts, working diagonally.

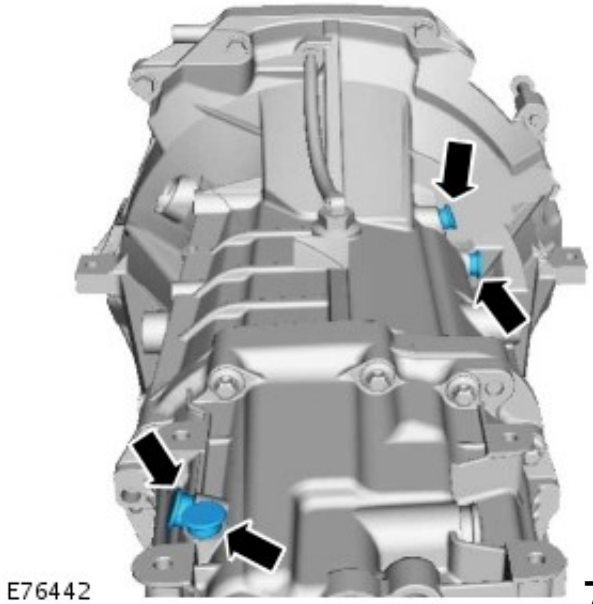


- Tighten to 24 Nm (18 lb.ft).

39. Reposition the locating dowels.

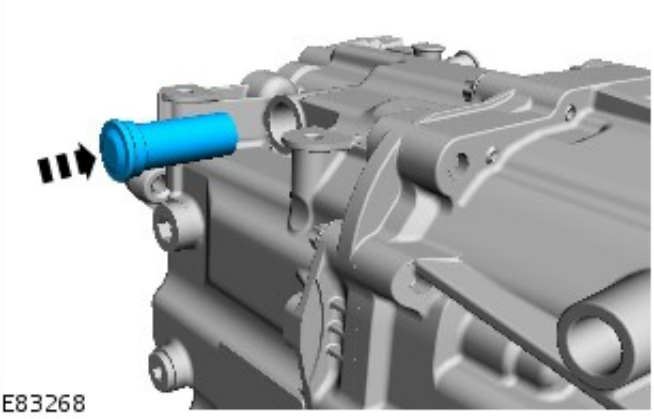


40. Install the new selector shaft detents.

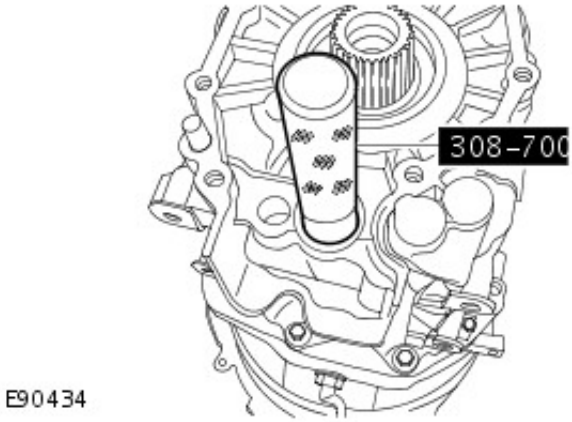


41. Move the main selector shaft to neutral.

42. Install the new selector shaft detent.

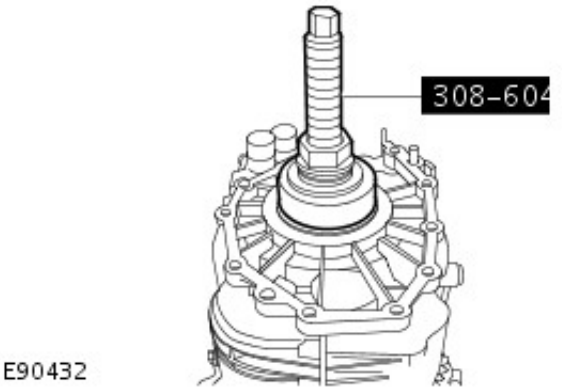

E83268

43. Using the special tool, install the main selector shaft seal.



E90434

44. Install the transmission output shaft seal.



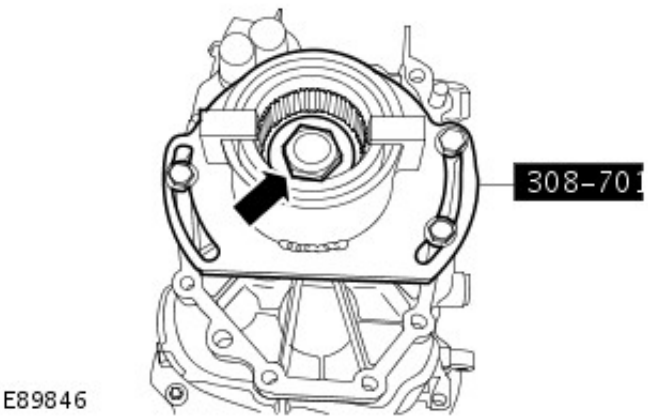
E90432

45. WARNING: Care should be taken when using the hot air gun. Failure to follow this instruction may result in personal injury.

• NOTE: Heat the transmission output flange to approx. 100 °C using a hot air gun.

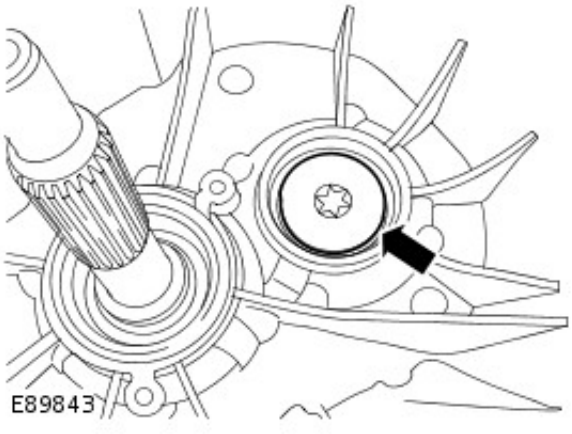
Using the special tool, install the transmission output flange.

- Tighten the bolt to 210 Nm (155 lb.ft).
- Loosen the bolt.
- Apply thread locking compound.adhesive
- Tighten the bolt to 180 Nm (133 lb.ft).



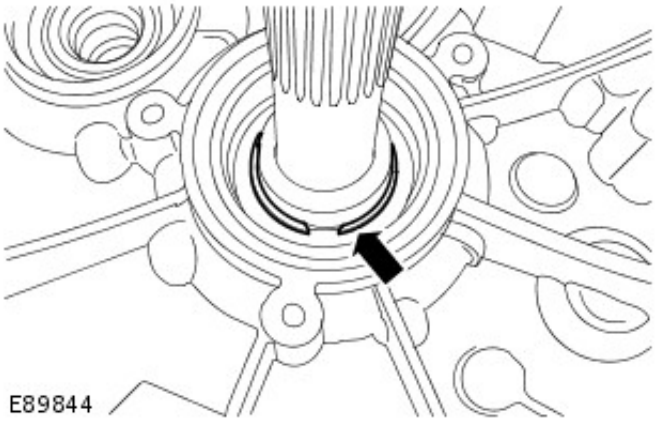
E89846

46. NOTE: Make sure that a gear is selected



Install the countershaft securing bolt.

- Tighten to 95 Nm (70 lb.ft).



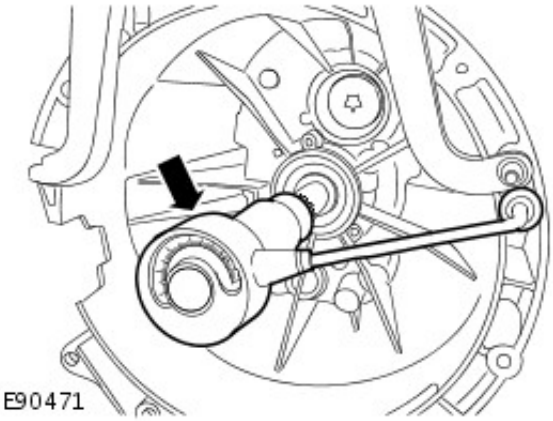
47. Install the input shaft snap ring.

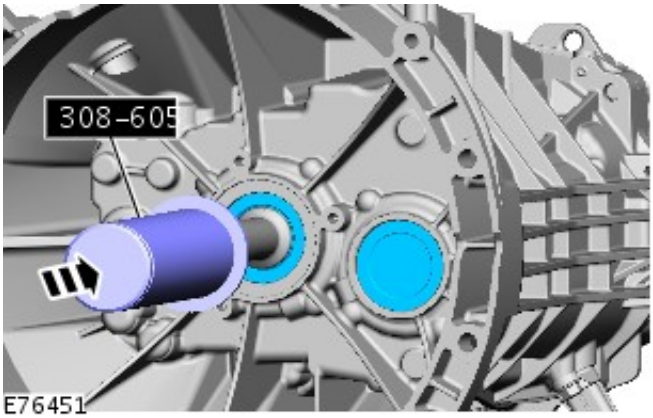
- Install a new snap ring.

48. Rotate the transmission shafts and check the availability of all gears.

49. With a suitable tool attached, check the torque in neutral with the output flange blocked.

- Torque 1.2 max Nm (1 lb.ft).





50. Using the special tool, install the transmission input shaft seal and countershaft seal.

51. Remove the transmission from the stand.

52. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

53. Install the transmission.
For additional information, refer to: Transmission (308-03 Manual Transmission/Transaxle, Removal).

54. Fill the transmission.
For additional information, refer to: Transmission Draining and Filling (308-03 Manual Transmission/Transaxle, General Procedures).

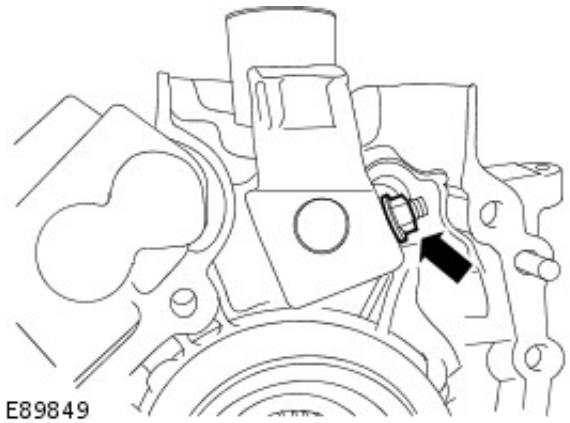
55. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Manual Transmission/Transaxle - Transmission
Installation

Special Tool(s)	
	Powertrain Assembly Jack HTJ1200-02
	Gear Selector Setting Tool 308-561

Installation

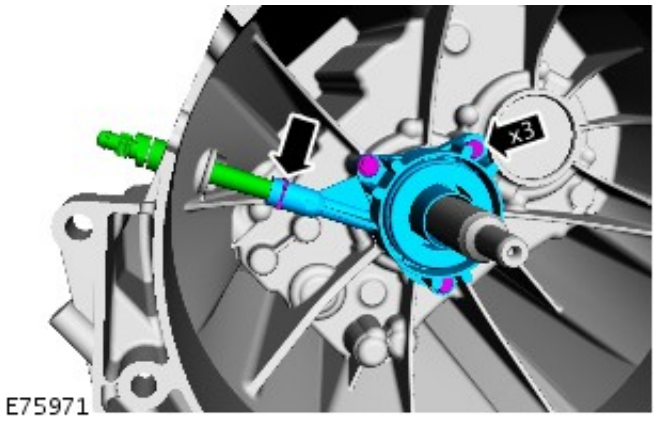
• NOTE: If a new transmission is being fitted then the gearshift lever retaining bolts must be pre installed to the transmission to cut the threads. Failure to follow this instruction will increase the difficulty of fitting the gearshift lever to the transmission.



1. NOTE: Make sure the pin is fitted from Left to Right when viewed from the rear of the transmission.

Install the gearshift yoke.

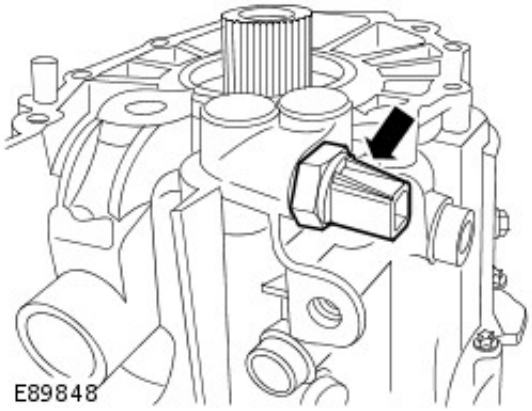
- Install the pin.
- Tighten the nut to 12 Nm (9 lb.ft).



2. Install the clutch slave cylinder.

- Tighten the bolts to 11 Nm (8 lb.ft).
- Install the connecting pipe.
- Install the connecting pipe securing clip.

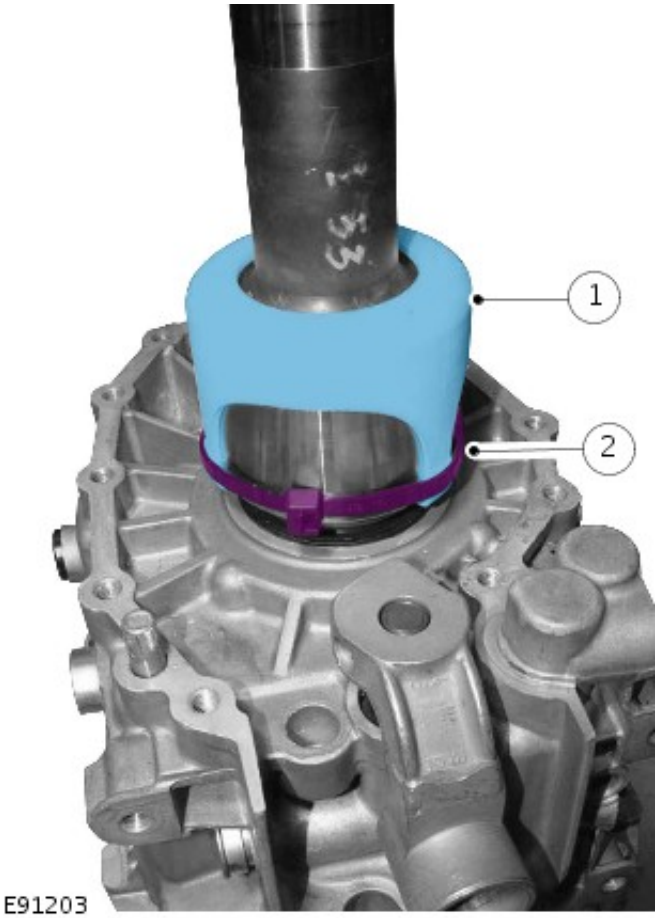
3. Install the reversing lamp switch.



3. Install the reversing lamp switch.
   - Tighten to 20 Nm (15 lb.ft).

4. Install the seal.

5. NOTE: Apply anti seize grease to the splines.



E91203

• NOTE: Make sure that the tie strap joint is between the fingers of the extension shaft seal cover and that it has been cut flush.

Install the transmission extension shaft.

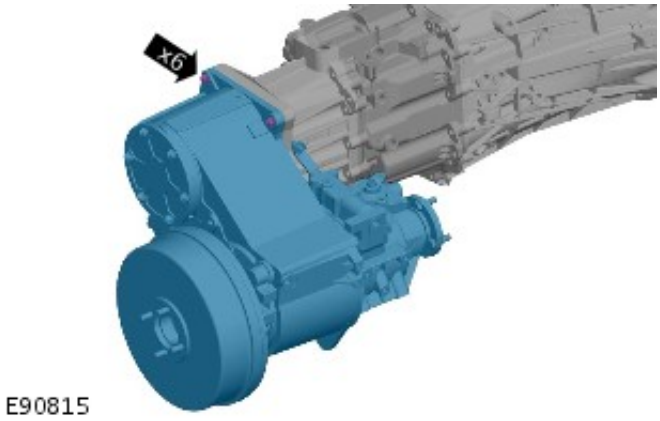
- Install the cover.
- Install the tie strap.

6. Install the transmission extension housing.

- Tighten the bolts to 25 Nm (18 lb.ft).

E91067

7. NOTE: Apply sealant STC 50552 to the bolt threads.



E90815

With assistance, install the transfer case.

- Tighten the bolts to 45 Nm (33 lb.ft).
- Tighten the nuts to 45 Nm (33 lb.ft).

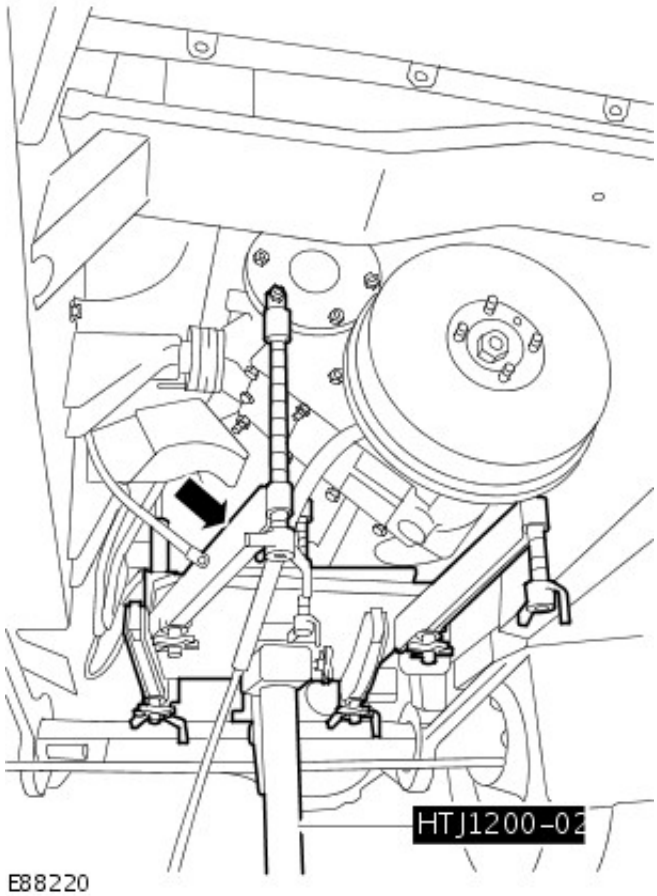
8. NOTE: This step must be carried out if a new transmission is being fitted.

Install the gear selector housing securing bolts to cut a new thread.

- Remove the bolts.

9. CAUTION: Care must be taken when locating the transmission to the clutch.

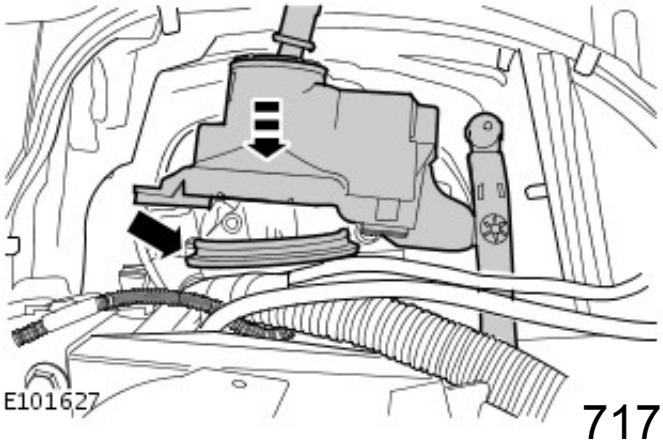
Install the transmission and transfer gearbox.

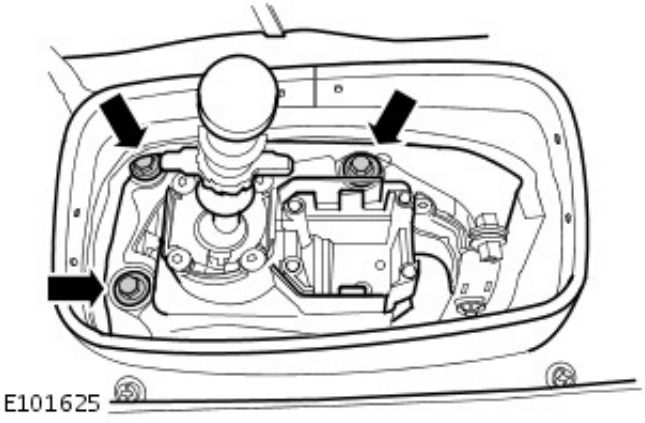


E88220

10. NOTE: Make sure the rubber gasket is fitted to the gearshift lever housing before installation.

Install the gear selector housing.


E101627



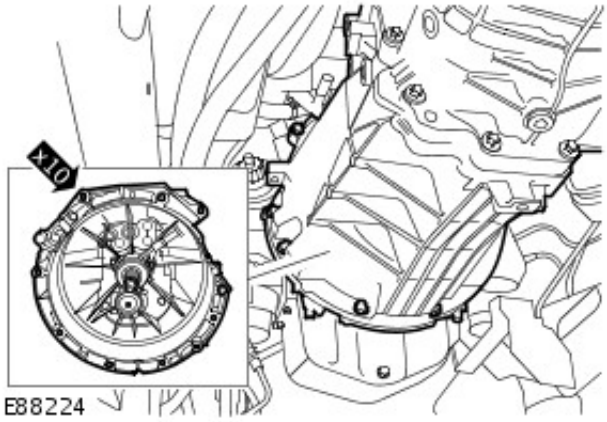
11. NOTE: From below the vehicle.

Install the 3 accessible gear selector housing securing bolts by hand only.

12. Position the transmission to the engine.

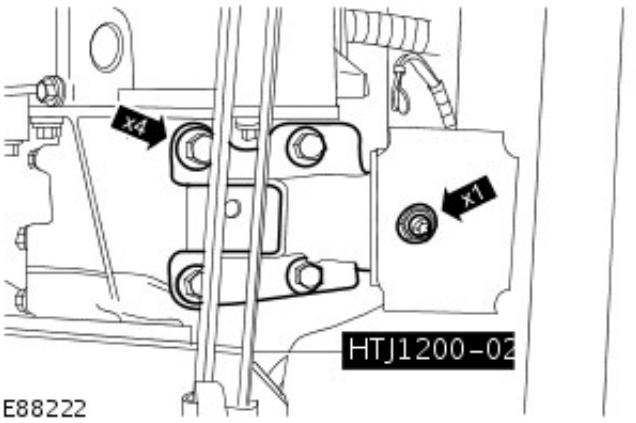
13. Install the bell housing bolts.

- Tighten to 40 Nm



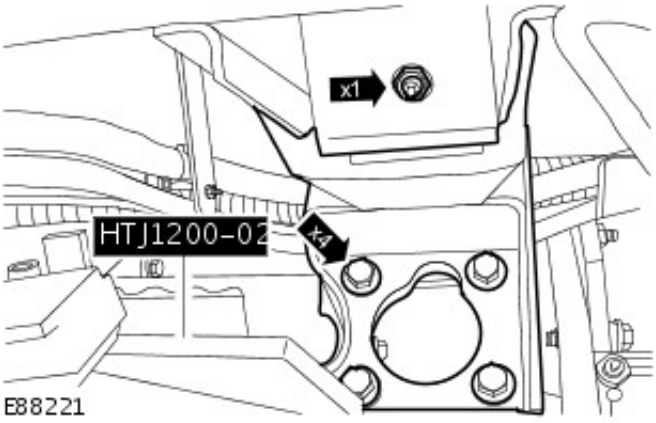
14. Install the RH transfer gearbox mounting bracket.

- Tighten the nut to 48 Nm
- Tighten the bolts to 85 Nm



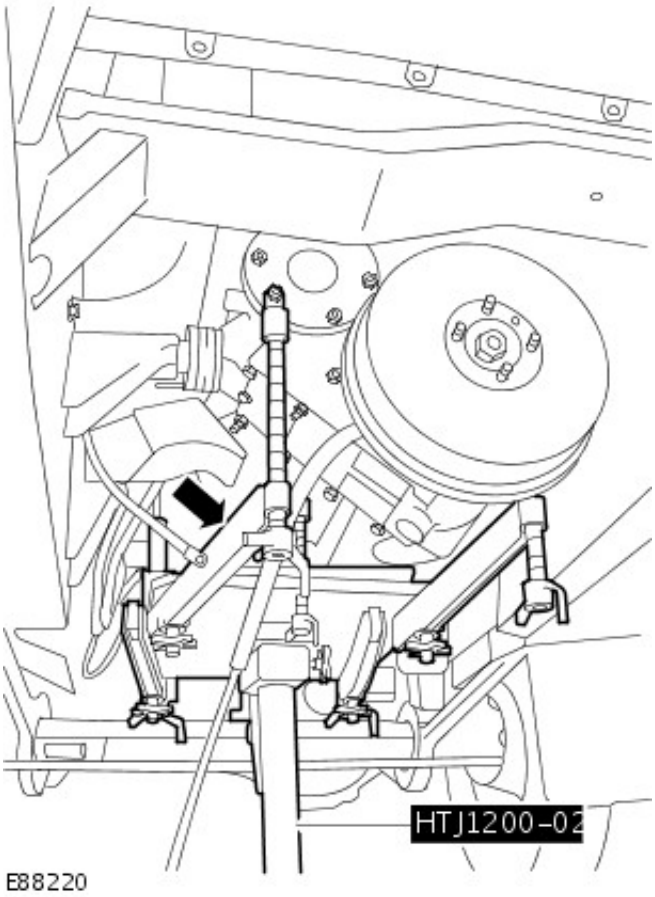
15. Install the LH transmission mount and mounting bracket.

- Tighten the nut to 48 Nm
- Tighten the bolts to 85 Nm



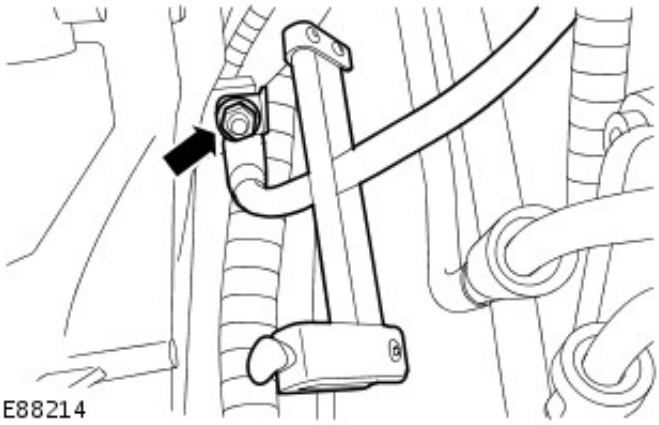
16. Remove the special tool HTJ1200-02 from the transmission

and transfer gearbox.



17. Connect the clutch slave cylinder fluid hose to the clutch slave cylinder.

- Remove the blanking plugs from the orifices.
- Install a new clutch slave cylinder fluid hose O-ring seal.
- Install the clutch slave cylinder line clip.

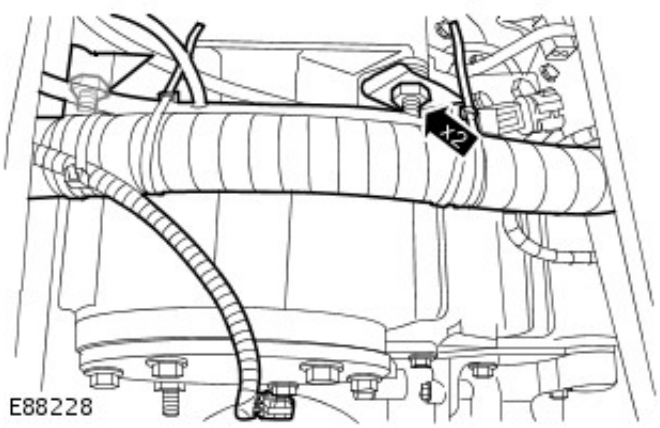


18. Install and fully tighten the clutch slave cylinder fluid hose mounting bracket securing nut and bolt.

- Remove the pipe clamp from the clutch slave cylinder fluid hose.
- Tighten the bolt to 25 Nm

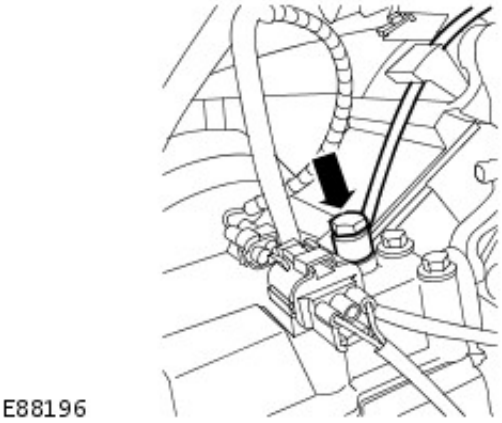
19. Secure the wiring harness to the transmission.

20. Reposition the transmission harness and install the



transmission harness retaining bracket securing nut and bolt.

- Tighten to 47 Nm



21. Install the transfer gearbox breather pipe.

- Install new sealing washers onto the transfer gearbox breather pipe securing bolt.
- Install the securing bolt.
- Tighten to 15 Nm.

22. Connect the differential lock detection switch electrical connector.

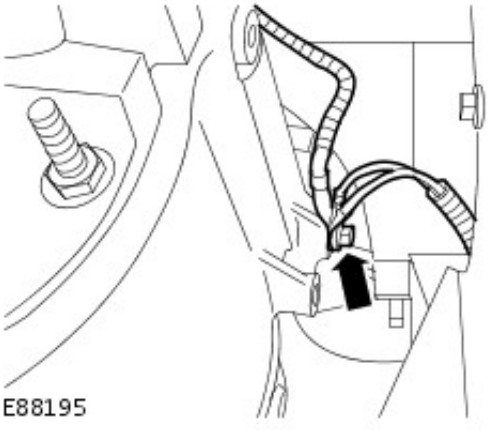
- Secure the electrical connector to the bracket.

23. Reposition and secure the high-low detection switch electrical connector onto the transfer gearbox.

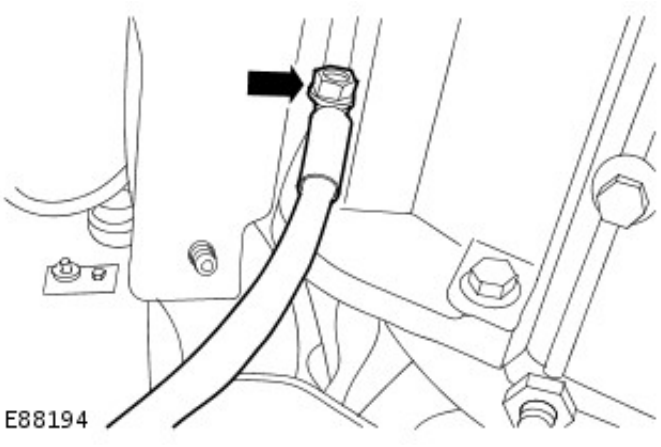
- Secure the electrical connector to the bracket.

24. Install the RH transfer gearbox earth cables securing bolt.

- Tighten to 12 Nm



25. Install the LH transfer gearbox earth cable securing nut.

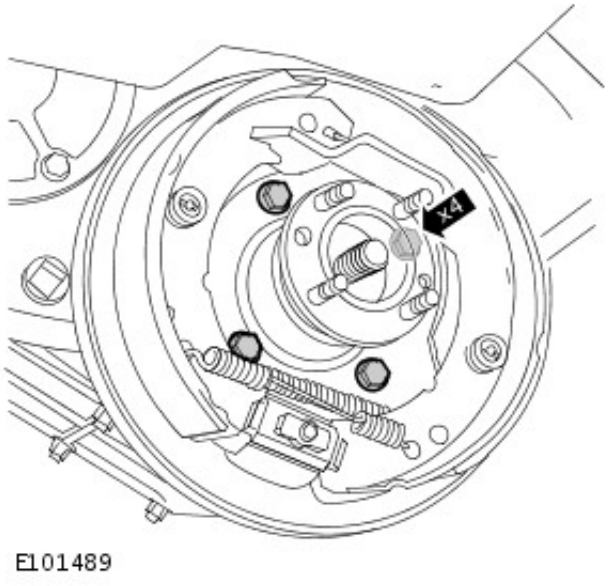


- Tighten to 45 Nm

26. Connect the electronic speedometer electrical connector to the transfer gearbox.

27. Install the parking brake assembly.

- Install the 4 securing bolts.
- Tighten to 73 Nm.



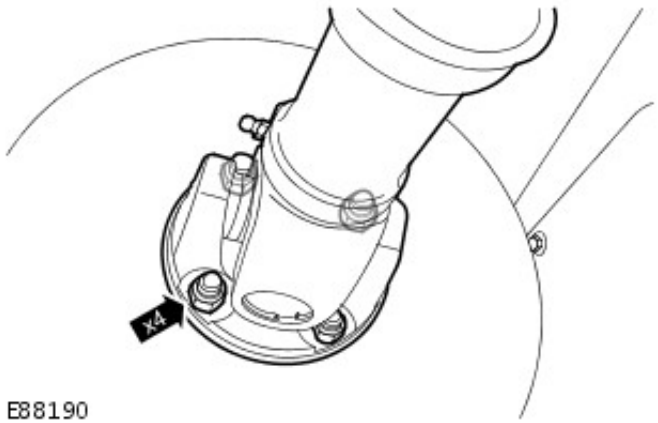
28. Install the parking brake drum.

- Install the securing screw.

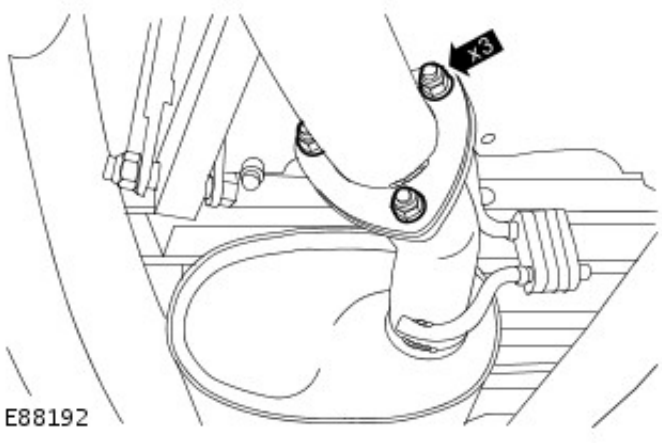
29. NOTE: Align to the position noted on removal.

Reposition and secure the rear driveshaft to the transfer gearbox.

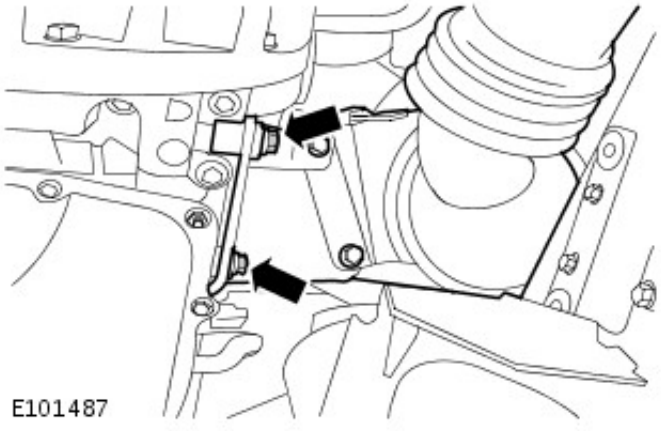
- Release the driveshaft from the chassis.
- Install the rear driveshaft to transfer gearbox securing bolts.
- Tighten to 47 Nm



30. Install and secure the intermediate pipe and muffler.

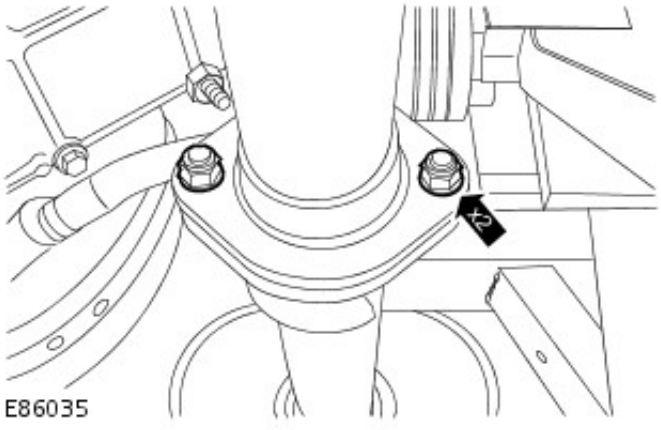


- Install a new gasket.
- Install the tailpipe and muffler, to intermediate pipe securing nuts.
- Tighten to 25 Nm



31. Install the catalytic converter.

- Clean the catalytic converter mating faces.
- Loosely install the 2 catalytic converter mounting bracket securing bolts.

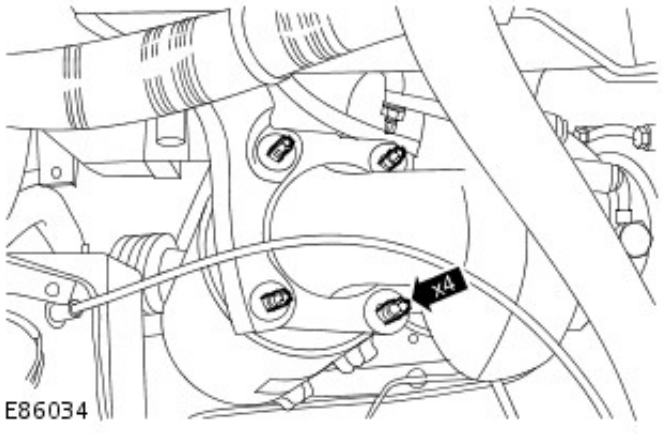


32. Secure the catalytic converter.

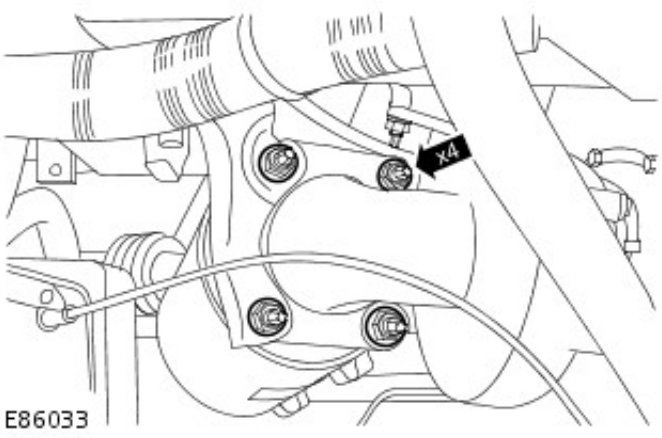
- Loosely install the catalytic converter to intermediate pipe securing nuts.

33. Lower the vehicle.

34. Install 4 new catalytic converter securing studs.



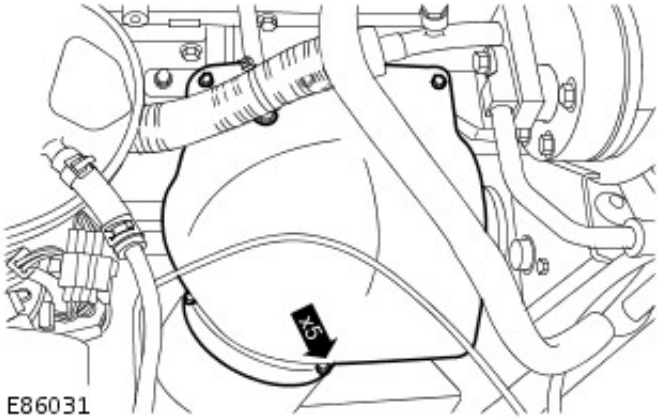
35. Install 4 new securing nuts.



- Tighten to 45 Nm

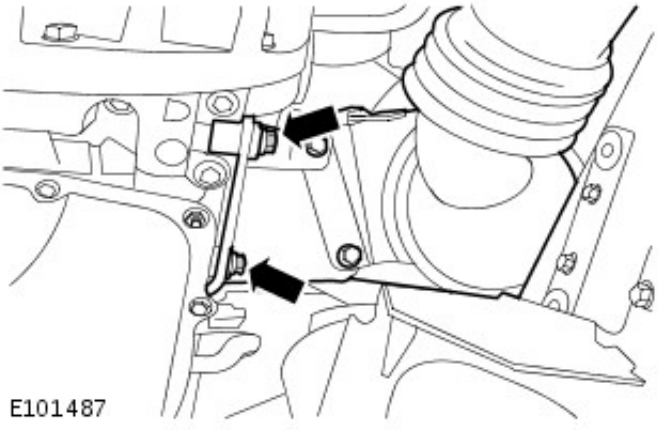
36. Install the turbocharger heat shield.

- Tighten to 10 Nm.

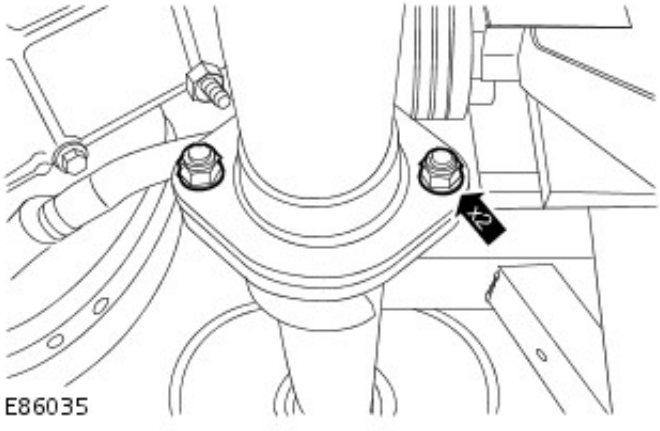


37. Close the bonnet.

38. Tighten to 30 Nm (22 lb.ft).

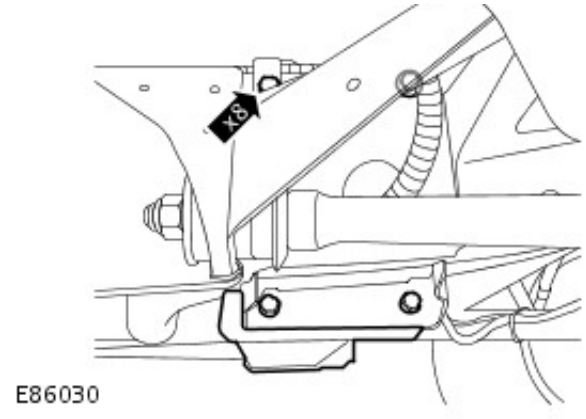


39. Tighten to 30 Nm (22 lb.ft).



40. Install the front driveshaft.
For additional information, refer to: Front Driveshaft (205-01 Driveshaft, Removal and Installation).

41. NOTE: Left-hand side shown, right-hand side similar.



Install the chassis cross member.

- Tighten to 85 Nm

42. Open the front door.

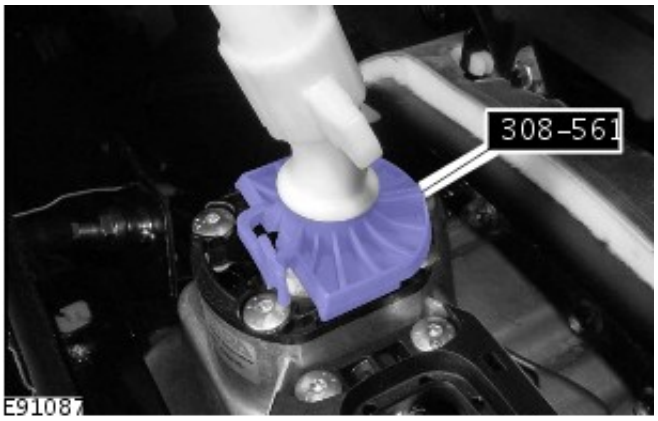
43. Connect the reverse light switch electrical connector.

44. NOTE: Make sure that the transmission is in third gear.

• NOTE: Make sure the gearshift selector lever ball joint bush and the selector yoke are centralised before installing the special tool.

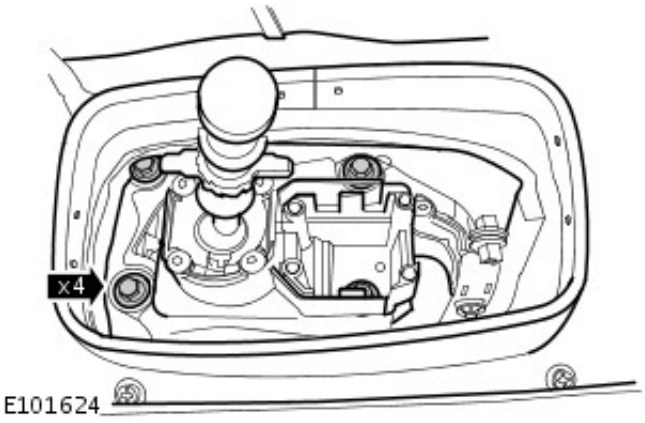
Install the gearshift lever.

- Install the special tool 308-561 onto the gear selector lever.

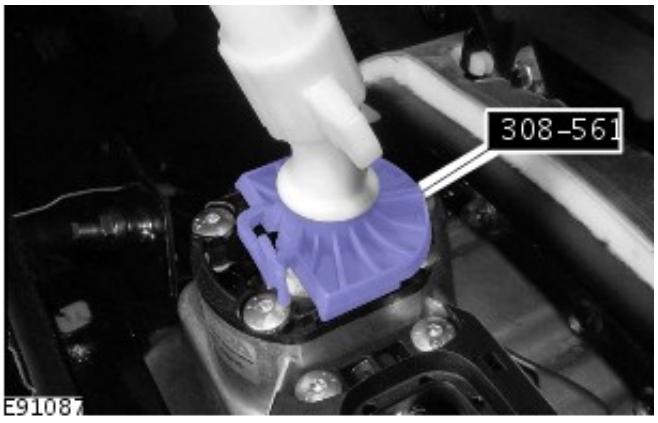


45. Tighten the 4 gear selector housing securing bolts.

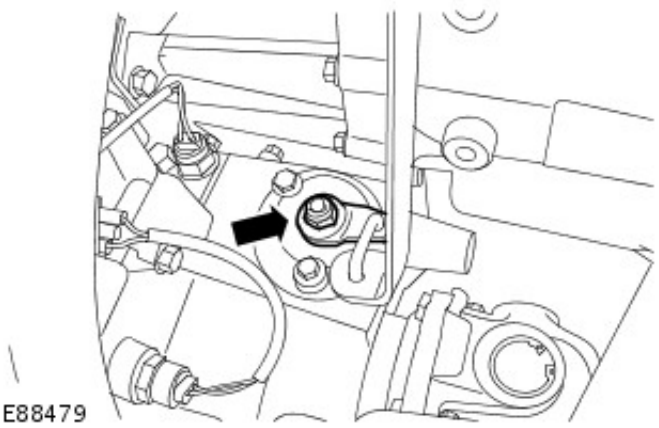
- Tighten to 25 Nm



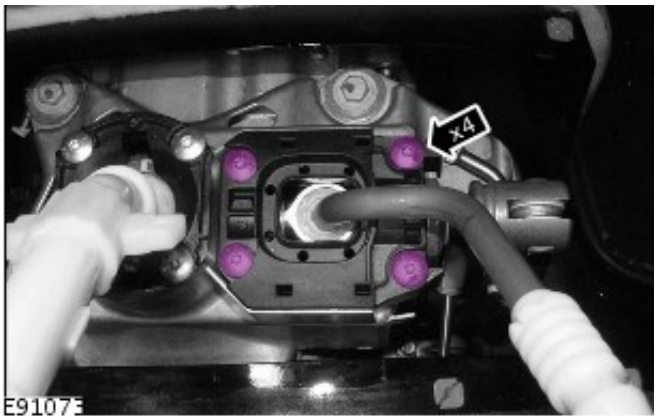
46. Remove the special tool 308-561 from the gear selector lever.



47. Install a new differential lock pivot nut.

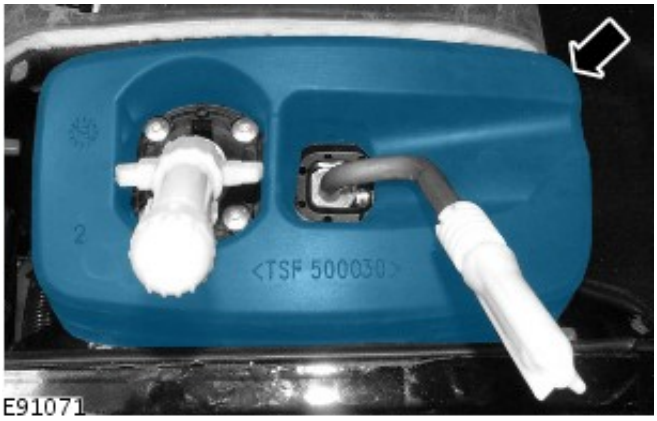


- Tighten to 25 Nm



48. Install the high-low selector lever onto the gearbox.

- Tighten to 7 Nm

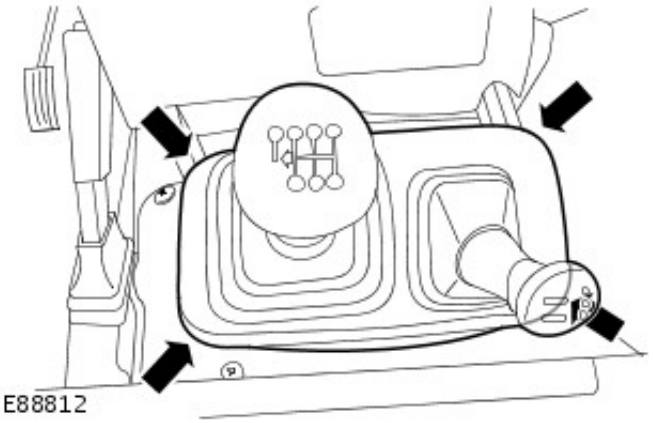


49. Install the foam pad.

50. Install the upper gear change lever.

51. Install the gear selector lever gaiter.

- Secure the gear selector lever gaitor to the transmission tunnel.
- Secure the gear selector lever gaitor to the high-low selector lever.



52. Install the transmission cover panel carpet.

53. Install the floor console assembly.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

54. Connect the battery ground cable.
For additional information, refer to: Battery Disconnect and

Connect (414-01 Battery, Mounting and Cables, General Procedures).

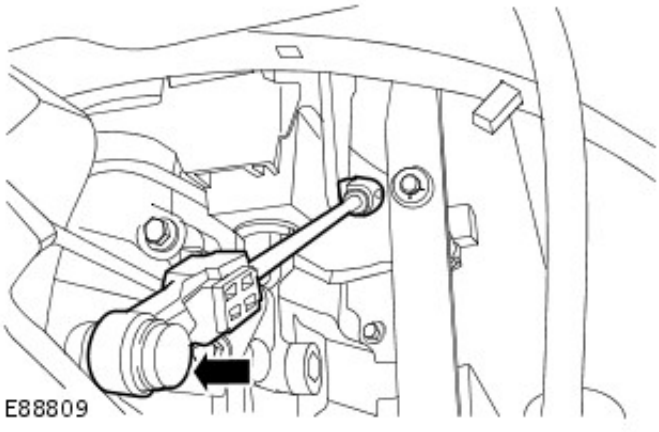
55. Install the battery cover.

56. Install the front seat cushion assembly.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

57. Raise the vehicle on the lift.

58. NOTE: Make sure the rod is fully engaged on the ball joint and not on the foam washer.

Install the high-low selector rod ball joint onto the transfer gearbox.



59. Bleed the clutch hydraulic system.
For additional information, refer to: Clutch System Bleeding (308-00 Manual Transmission/Transaxle and Clutch - General Information, General Procedures).

60. Lower the vehicle.

Manual Transmission/Transaxle External Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Torque Specifications

Description	Nm	lb-ft
Differential lock pivot nut	25	18
Gearshift lever bolts	25	18
High/Low selector lever screws	7	5

Manual Transmission/Transaxle External Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - External ControlsVehicles With: 6-Speed Manual Transmission - MT82

Description and Operation

OVERVIEW

For additional information, refer to: Manual Transmission - Vehicles With: 6-Speed Manual Transmission - MT82 (308-03 Manual Transmission/Transaxle, Description and Operation).

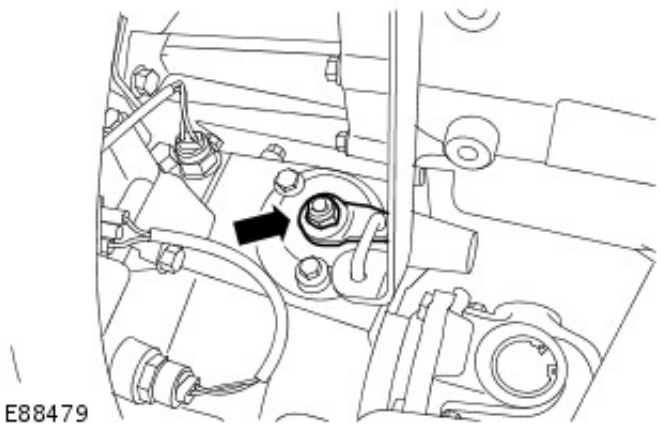
Manual Transmission/Transaxle External Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Gearshift Lever

Removal and Installation

Removal

1. Remove the transfer case high/low range linkage.
For additional information, refer to: Transfer Case High/Low Range Linkage (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

2. Remove and discard the differential lock pivot nut.

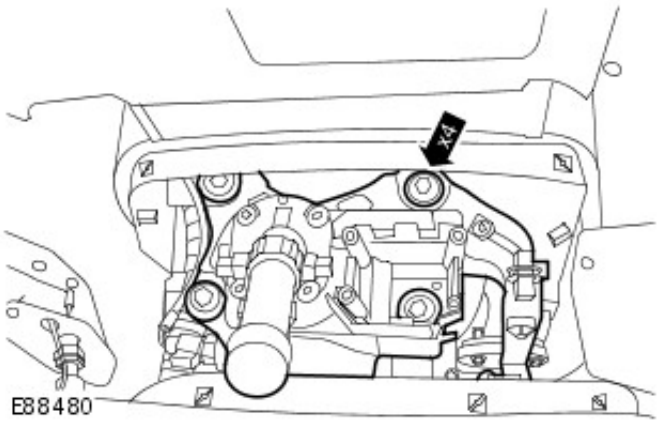


3. NOTE: Do not remove the 4 gearshift lever ball joint securing screws.

• NOTE: Make sure the rubber seal is not damaged on removal.

Remove the gearshift lever.

- Remove the 4 bolts.



Installation

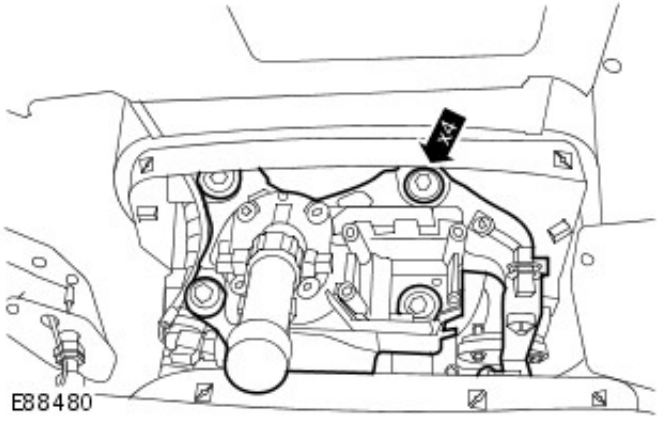
1. NOTE: Make sure the gearshift selector lever ball joint bush and the selector yoke are centralised before installing the special tool.

• NOTE: Make sure the rubber gasket is fitted to the gearshift lever housing before installation.

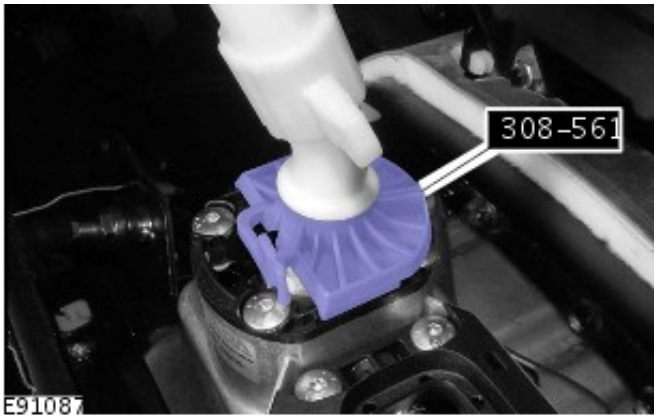
Install the gearshift lever.

- Make sure 3rd gear is engaged on the transmission.
- Install the gearshift lever.
- Install the special tool onto the gearshift lever.

2. Tighten the bolts to 25 Nm (18 lb.ft).

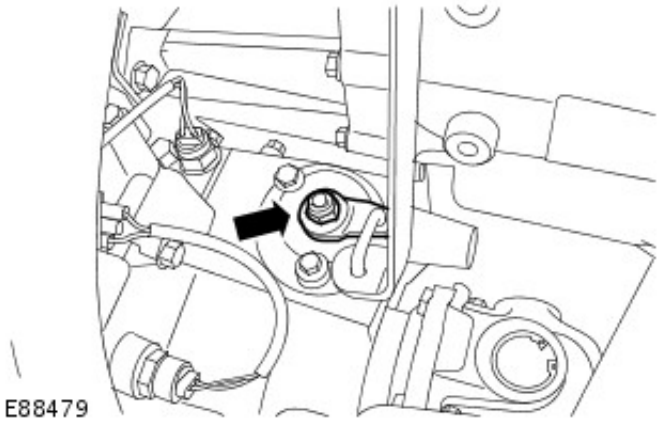


3. Remove the special tool.



4. Install a new differential lock pivot nut.

- Tighten the nut to 25 Nm (18 lb.ft).



5. Install the transfer case high/low range linkage.
For additional information, refer to: Transfer Case High/Low Range Linkage (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Lubricants

Item	Specification
Recommended oil	API GL4 or GL5, MIL-L-2105 or MIL-L-2105B
Capacity	2.3 litres, (4.0 pints)

CAUTION: Do not use any lubricant other than that specified

General Specification - LT230Q

Item	Specification
Transfer case type	LT230QRS
Specification	Two speed reduction on main gearbox output, front and rear drive permanently engaged via a lockable differential
Ratios:	
High	1.211:1
Low	3.269:1

Transfer case data

Item	Metric	Imperial
High/low selector finger width	15.90 to 15.95 mm	0.625 to 0.627 in
High/low selector fork finger width	7.37 to 7.47 mm	0.290 to 0.294 in
High/low selector shaft groove width	16.0 to 16.1 mm	0.63 to 0.64 in
High/low selector hub groove width	7.5 to 7.6 mm	0.295 to 0.30 in
Differential lock selector finger width	15.90 to 15.95 mm	0.625 to 0.627 in
Differential lock selector shaft groove width	16.0 to 16.1 mm	0.63 to 0.64 in
Differential lock selector fork finger width	7.92 to 7.9 mm	0.311 to 0.313 in
Differential lock selector spring free length	84.58 mm	3.33 in
Dog clutch selector fork groove width	8.05 to 8.20 mm	0.32 to 0.33 in
Differential front and rear half carrier gears load to turn:		
Used gears	0.45 kg	1.0 lb
New gears	1.72 kg	3.8 lb
Thrust washer thicknesses available	1.05 to 1.45 mm	0.04 to 0.06 in
In increments of:	0.10 mm	0.004 in
Total load to turn - both sun gears fitted:		
Used gears	0.90 kg	2.0 lb
New gears	3.44 kg	7.6 lb
Low range gear to high range hub clearance	0.05 to 0.15 mm	0.002 to 0.006 in
High range gear to high/low hub clearance	0.05 to 0.10 mm	0.002 to 0.004 in
Mainshaft input gear bearing pre-load	0.05 mm	0.002 in
Mainshaft input gear bearing shim thicknesses	3.15 to 4.00 mm	0.12 to 0.16 in
In increments of:	0.05 mm	0.002 in
Differential bearing pre-load	0.05 mm	0.002 in
Differential shim thicknesses available		
In increments of	0.05 mm	0.002 in
Transfer case gear train torque to turn	3.4 Nm max	30 lbf.in max

Torque Specifications

Description	Nm	lb-ft
Drain plug	30	22
Transfer case breather banjo	15	11
Differential carrier bolts	60	44
Differential bearing nut	72	53
Differential lock selector lever nut	25	18
* Front output housing bolts	25	18
* Rear output housing bolts	45	33
*** Output flange nuts	162	120
* Differential lock selector housing bolts	25	18
High/low selector housing bolts	25	18
* Intermediate shaft retaining plate bolt	25	18
*** Intermediate shaft stake nut - Selective length non-collapsible spacer	88	65
* Bottom cover bolts	25	18
* Bearing housing cover plate bolts and stud nut	25	18
Transmission brake backplate bolts	72	54
Interlock solenoid cover bolts - if fitted	10	8
** Neutral warning lamp switch	25	18
Transfer case front drive flange to drive shaft	47	33

Transfer case rear drive flange to drive shaft	50	37
Transfer case to gearbox extension case	47	33

* Apply Loctite 290 to threads

** Apply Hylomar PL32 to threads

*** New nut must be fitted

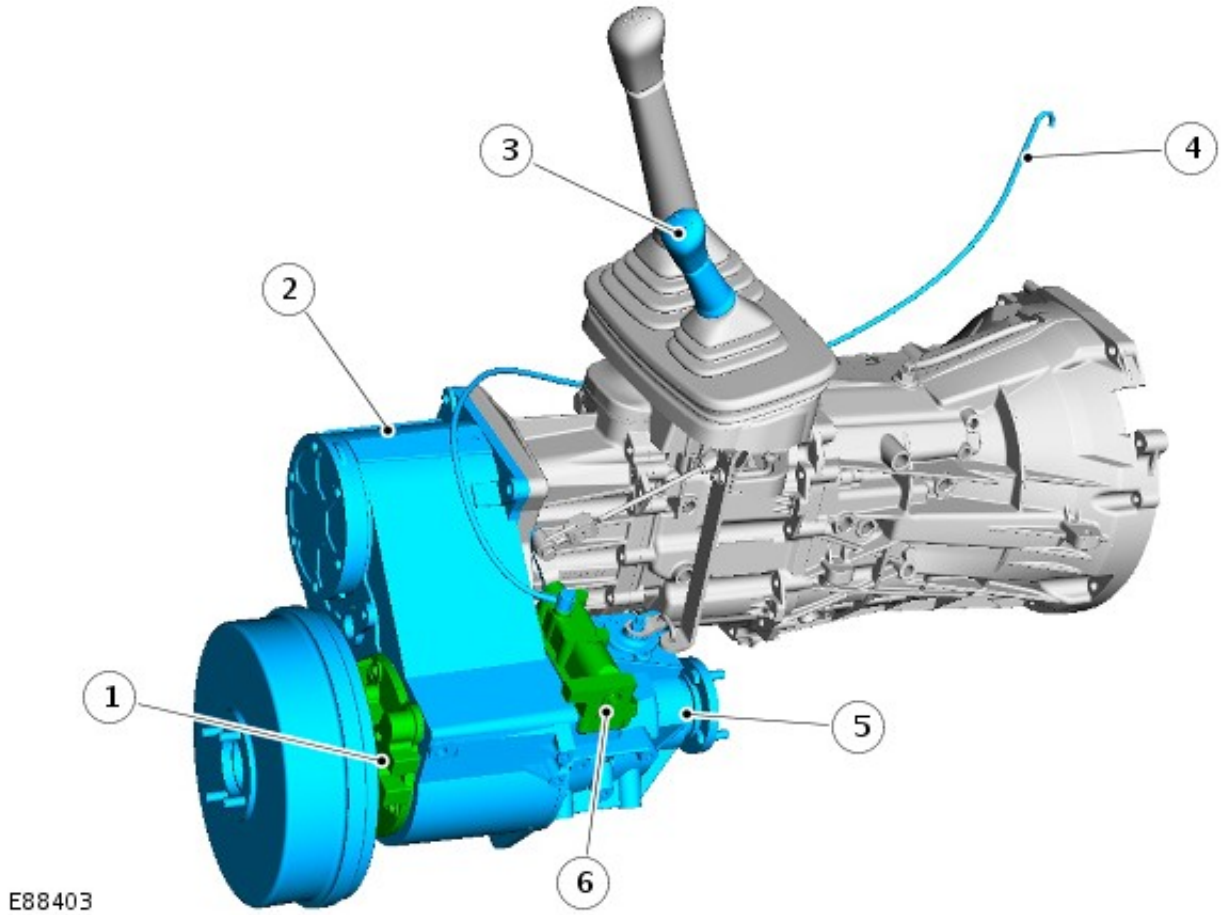
Item	Nm	lbf-ft
METRIC		
M5	6	5
M6	9	7
M8	25	18
M10	45	33
M12	90	65
M14	105	75
M16	180	130
UNF/UNC		
1/4	9	7
5/16	25	18
3/8	40	30
7/16	80	60
½	90	65
5/8	135	100

The table above provided torque values for screws and bolts not previously specified.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer CaseVehicles With: 6-Speed Manual Transmission - MT82

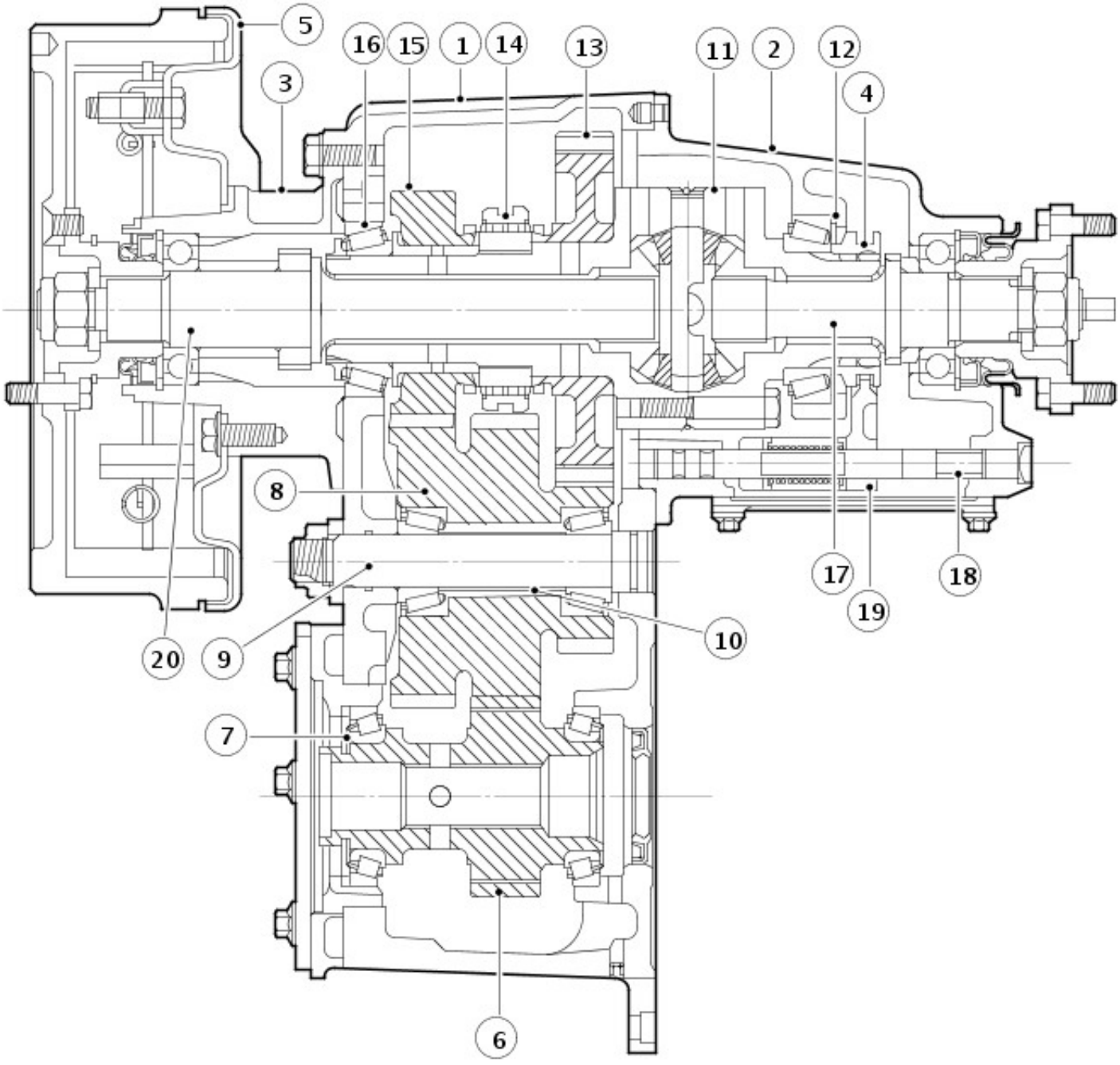
Description and Operation

COMPONENT LOCATION



Item	Part Number	Description
1	-	Rear output housing
2	-	Main casing
3	-	Transfer box selector lever
4	-	Breather pipe
5	-	Front output housing
6	-	Selector housing

TRANSFER CASE CROSS SECTION



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Item	Part Number	Description
1	-	Main casing
2	-	Front output housing
3	-	Rear output housing
4	-	Dog clutch
5	-	Transmission brake
6	-	Mainshaft input gear

7	-	Selective shim - input gear bearing pre-load
8	-	Intermediate gear cluster
9	-	Intermediate shaft
10	-	Spacer
11	-	Differential assembly
12	-	Selective shim - differential bearing pre-load
13	-	Low range gear
14	-	High/low selector sleeve and hub
15	-	High range gear and bush
16	-	Differential rear bearing
17	-	Front output shaft
18	-	Differential lock selector shaft
19	-	Selector fork
20	-	Rear output shaft

OVERVIEW

The transfer box is a permanent 4-wheel drive, 2-speed ratio reducing transmission, incorporating high and low range outputs with mechanically lockable centre differential (diff-lock). High range has a ratio of 1.211:1 and low range 3.269:1.

High/low range and diff-lock selection are made via a single lever located next to the main gear lever.

The unit is mounted at the rear of the main transmission and transmits drive to the front and rear drive axle differentials via the drive shafts.

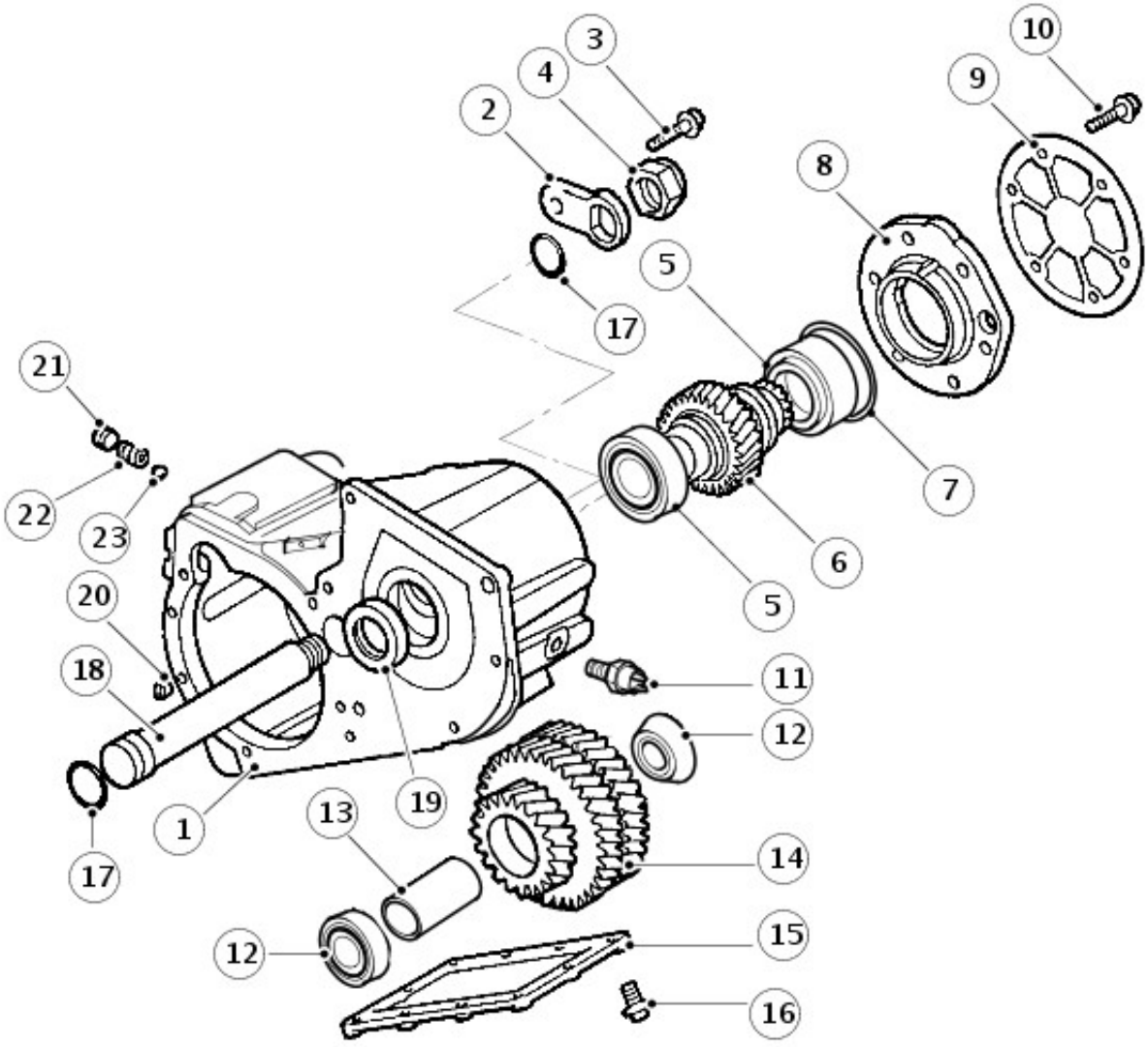
Integral with the output shafts is a differential assembly, which compensates for speed differences between the front and rear drive shafts. To improve traction and prevent all the power being transmitted to the drive axle differential offering the least traction, a diff-lock is provided. The diff-lock should only be engaged during severe off-road conditions where traction is poor and should be disengaged as soon as conditions permit, for example, when good traction is available. Selection of differential lock engages, through mechanical linkage, a dog clutch with the front output shaft, this action locks the centre differential and provides a fixed drive, giving equal power to the front and rear drive shafts.

The transfer box comprises 3 main assemblies:

- The main casing
- The front output housing
- The rear output housing

All housings and cover plates are sealed to the main casing by sealant. Output flange rotary seals are protected against mud and water ingress by mud shield flingers.

THE MAIN CASING



Item	Part Number	Description
1	-	Main casing
2	-	Retaining plate
3	-	Bolt - retaining plate
4	-	Stake nut - intermediate shaft
5	-	Bearings and outer tracks - mainshaft input gear
6	-	Mainshaft input gear
7	-	Selective shim
8	-	Mainshaft input gear bearing housing
9	-	Cover plate/power take-off cover
10	-	Bolt - cover plate
11	-	Oil temperature switch (if fitted)
12	-	Bearings and outer tracks - intermediate gears
13	-	Collapsible spacer
14	-	Intermediate gears
15	-	Bottom cover plate
16	-	Bolt - bottom cover plate
17	-	O-rings - intermediate shaft
18	-	Intermediate shaft
19	-	Mainshaft oil seal
20	-	Locating dowel
21	-	Detent plug - high/low selector
22	-	Detent spring - high/low selector
23	-	Detent ball - high/low selector

The main casing carries:

- the mainshaft input gear

- the intermediate gears
- the centre differential assembly

The front and rear output housings are bolted to either side of the main casing.

Mainshaft Input Gear

The transmission output shaft is splined into the mainshaft input gear, which is supported by taper roller bearings.

Input gear bearing pre-load is achieved by the use of a selective shim located in the bearing housing.

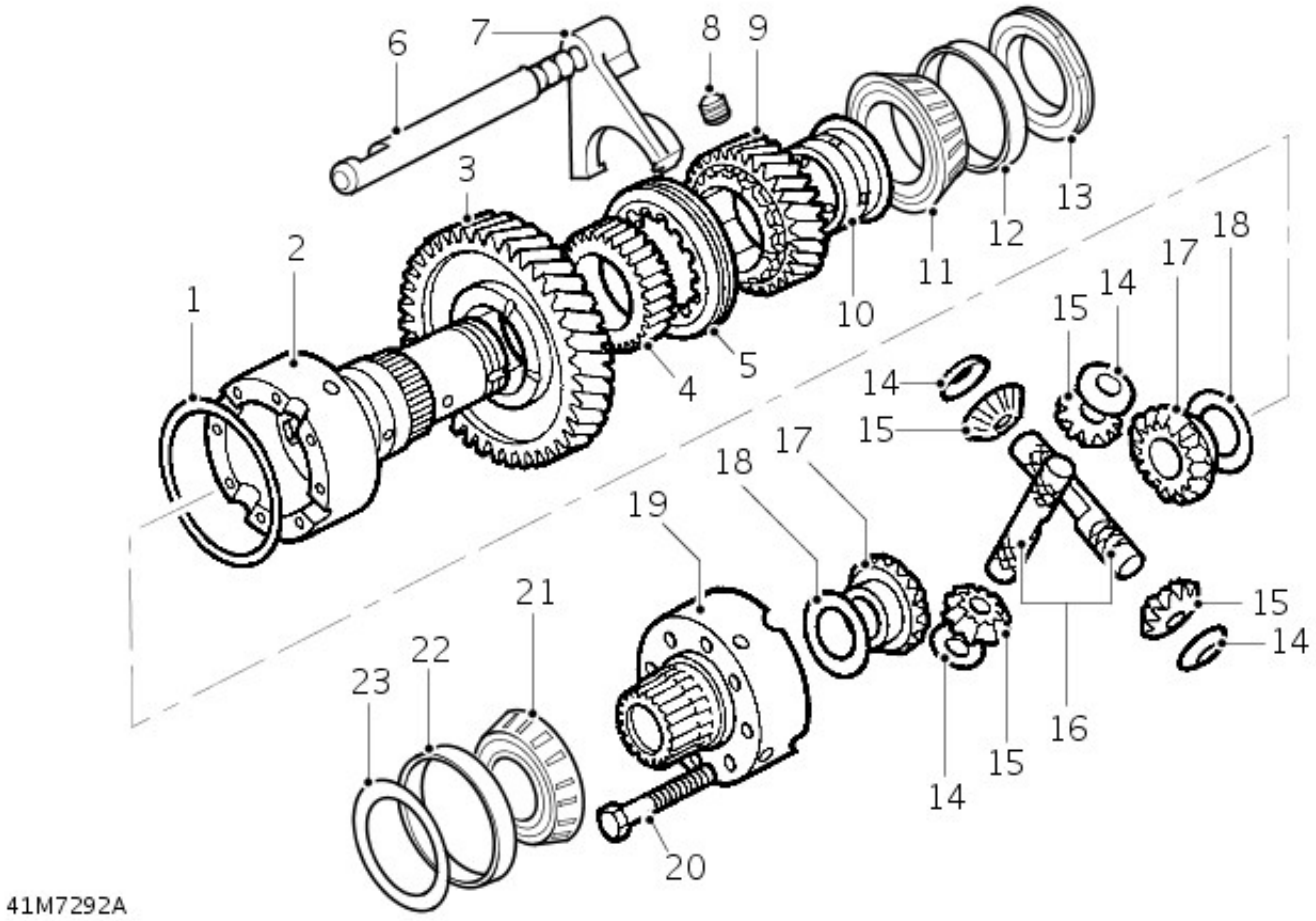
Intermediate Gears

The intermediate gear cluster is supported by the taper roller bearings located at each end of the cluster and runs on the intermediate shaft, which in turn, is supported at the front and rear by the main casing.

Intermediate gear bearing pre-load is achieved by means of a collapsible spacer positioned between the bearings, the amount of compression applied to the spacer is by means of a nut on the end of the intermediate shaft.

The bore of the intermediate gear is machined with a shoulder at each end to locate the bearings.

Centre Differential Assembly



Item	Part Number	Description
1	-	Retaining ring
2	-	Differential carrier - rear half
3	-	Low range gear
4	-	High/low hub
5	-	High/low selector sleeve
6	-	High/low selector shaft
7	-	High/low selector fork
8	-	Setscrew - high/low selector fork
9	-	High range gear
10	-	High range gear bush
11	-	Differential rear bearing
12	-	Bearing outer track
13	-	Bearing retaining nut
14	-	Dished thrust washers
15	-	Differential planet gears

16	-	Cross shafts
17	-	Differential side gears
18	-	Selective thrust washers
19	-	Differential carrier - front half
20	-	Bolt - differential carriers
21	-	Differential front bearing
22	-	Bearing outer track
23	-	Selective shim

The centre differential assembly is supported at the front and rear by taper roller bearings, the front bearing outer track is located in the front output housing and the rear bearing outer track is located in the main casing by the rear output housing. Bearing pre-load is achieved by means of a selective shim located in the front output housing.

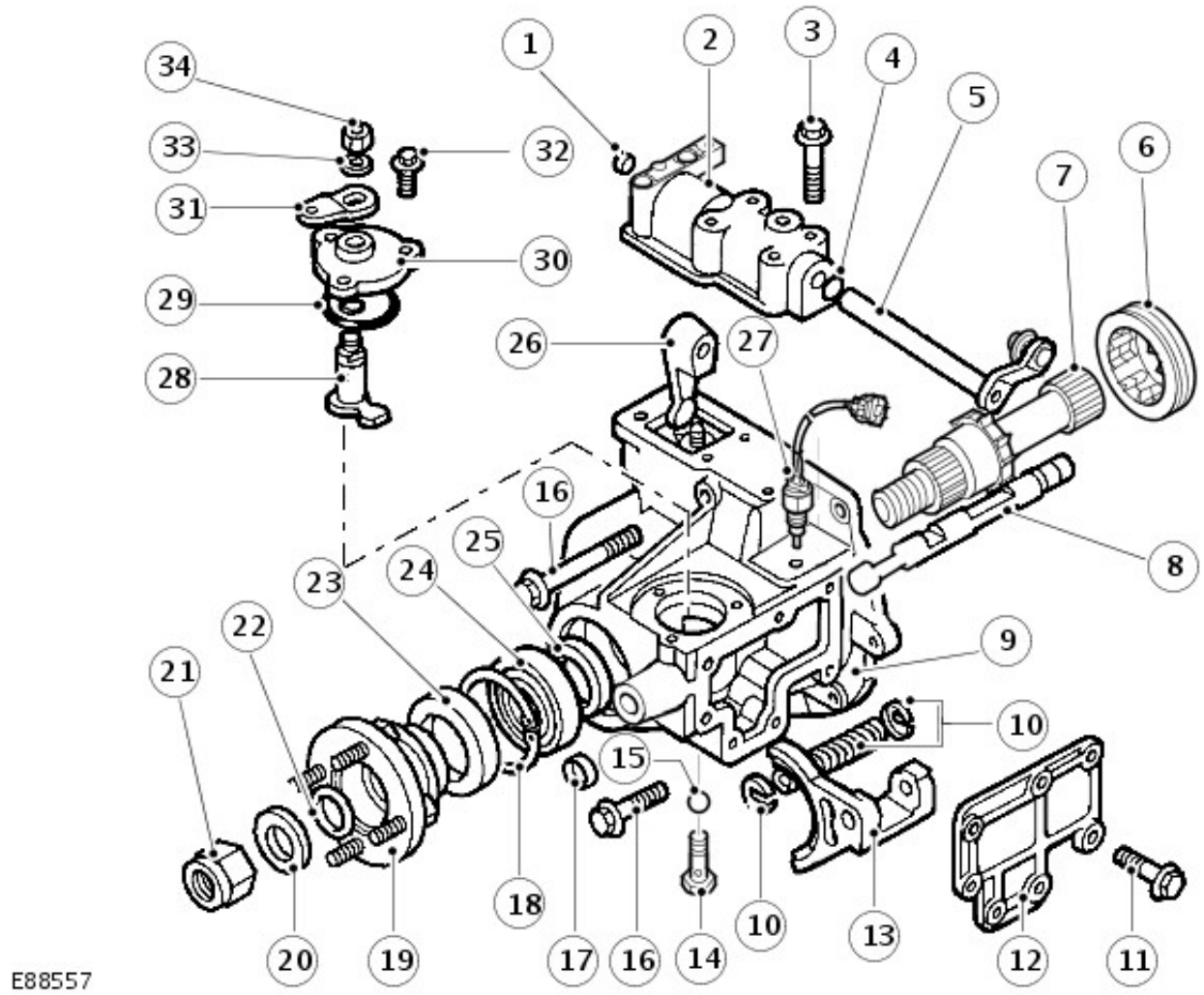
The centre differential rear shaft carries the low range gear, high/low selector sleeve and hub, high range gear and bush and the differential rear bearing; these components being secured to the shaft by a special staked nut.

The assembly comprises front and rear half carriers with integral shafts connected to differential side gears and planet gears mounted on cross shafts within the half carriers. Dished, non-selective thrust washers control the engagement of the planet gears with the differential side gears, whilst selective thrust washers are used to control engagement of the differential side gears and 'torque to turn' of the differential. The differential carrier halves are bolted together, a retaining ring providing positive location of the cross shafts.

The high/low selector shaft and fork are located at the side of the differential, movement of the shaft, fork and selector sleeve being controlled by the high/low selector finger. A spring loaded detent ball fitted in the main casing, locates in grooves in the shaft.

The selector fork is fitted with a spring assister and clips to reduce the effort required to move the selector lever.

FRONT OUTPUT HOUSING



Item	Part Number	Description
1	-	Hollow plug
2	-	High/low cross shaft housing
3	-	Bolt - high/low cross shaft housing
4	-	O-ring
5	-	High/low cross shaft and lever with cable ball end

6	-	Dog clutch
7	-	Front output shaft
8	-	Differential lock selector shaft
9	-	Front output housing
10	-	Spring and clips - differential lock
11	-	Bolt - Cover plate
12	-	Cover plate
13	-	Differential lock selector fork
14	-	Detent plug and spring - differential lock
15	-	Detent ball - differential lock
16	-	Bolt - front output housing
17	-	Plug
18	-	Circlip
19	-	Output shaft flange and mud shield
20	-	Steel washer
21	-	Self-locking nut
22	-	Felt washer
23	-	Oil seal
24	-	Output shaft bearing
25	-	Bearing spacer
26	-	High/low selector finger
27	-	Differential lock warning indicator switch
28	-	Differential lock selector finger and shaft
29	-	O-rings
30	-	Differential lock selector housing
31	-	Selector lever
32	-	Bolt - housing
33	-	Washer
34	-	Self-locking nut

The front output housing carries:

- the front output shaft and flange
- the housing and selector
- the differential lock selector shaft and fork

Front Output Shaft and Flange

The front output shaft is supported in the housing by a single bearing and is splined into the differential front sun gear.

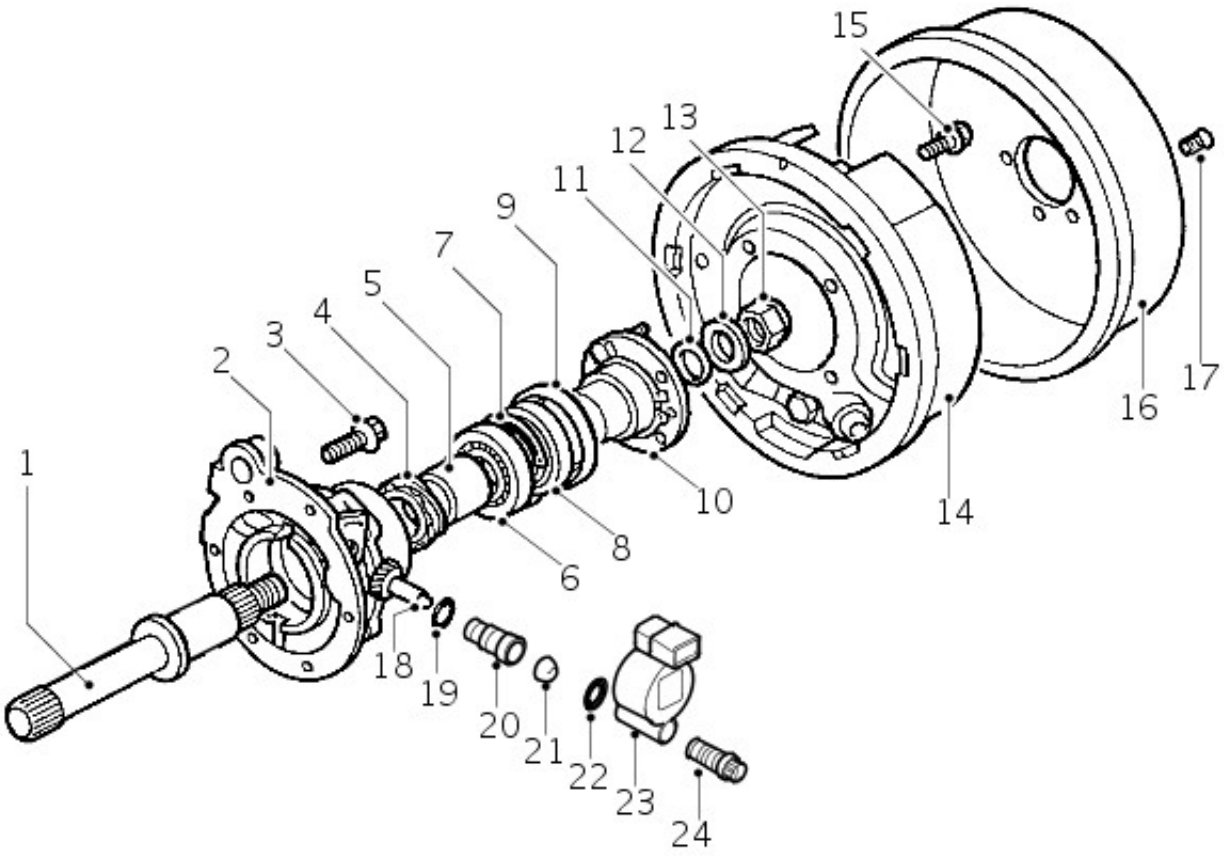
Housing and Selector Assembly

A high/low cross shaft is located in a housing bolted to the top of the output housing and is connected to the high/low selector finger, which locates in a slot in the selector shaft.

Differential Lock Selector Shaft and Fork

The differential lock selector housing is bolted to the top of the front output housing, the selector finger passes through the housing, locating in a slot in the differential lock selector shaft. The differential lock selector shaft passes through the selector fork, which is located beneath a plate bolted to the side of the output housing. The selector fork engages the dog clutch sleeve with the differential rear shaft when the splines of the sleeve and differential rear shaft are aligned. A spring loaded detent ball fitted in the output housing locates in grooves in the shaft.

REAR OUTPUT HOUSING



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Item	Part Number	Description
1	-	Rear output shaft
2	-	Rear output housing
3	-	Bolt - rear output housing
4	-	Speedometer drive gear
5	-	Spacer
6	-	Output shaft bearing
7	-	Circlip
8	-	Oil seal
9	-	Mud shield
10	-	Output shaft flange
11	-	Felt washer
12	-	Steel washer
13	-	Self-locking nut
14	-	Transmission brake backplate
15	-	Bolt - transmission brake backplate
16	-	Transmission brake drum
17	-	Countersunk screw
18	-	Speedometer driven gear
19	-	O-ring
20	-	Speedometer driven gear housing
21	-	Seal
22	-	O-ring
23	-	Vehicle speed sensor (if fitted)
24	-	Allen screw (if fitted)

The rear output housing carries the output shaft and flange and the speedometer drive and driven gears. A mechanically operated transmission brake is attached to the housing, the brake drum being attached to the output flange.

The rear output shaft is supported in the rear output housing by a single bearing and is splined into the differential rear shaft. The output shaft also carries the speedometer drive gear, which meshes with the speedometer driven gear located in the rear output housing.

A differential lock warning lamp switch operated by movement of the selector fork and shaft is screwed into the top of the output housing.

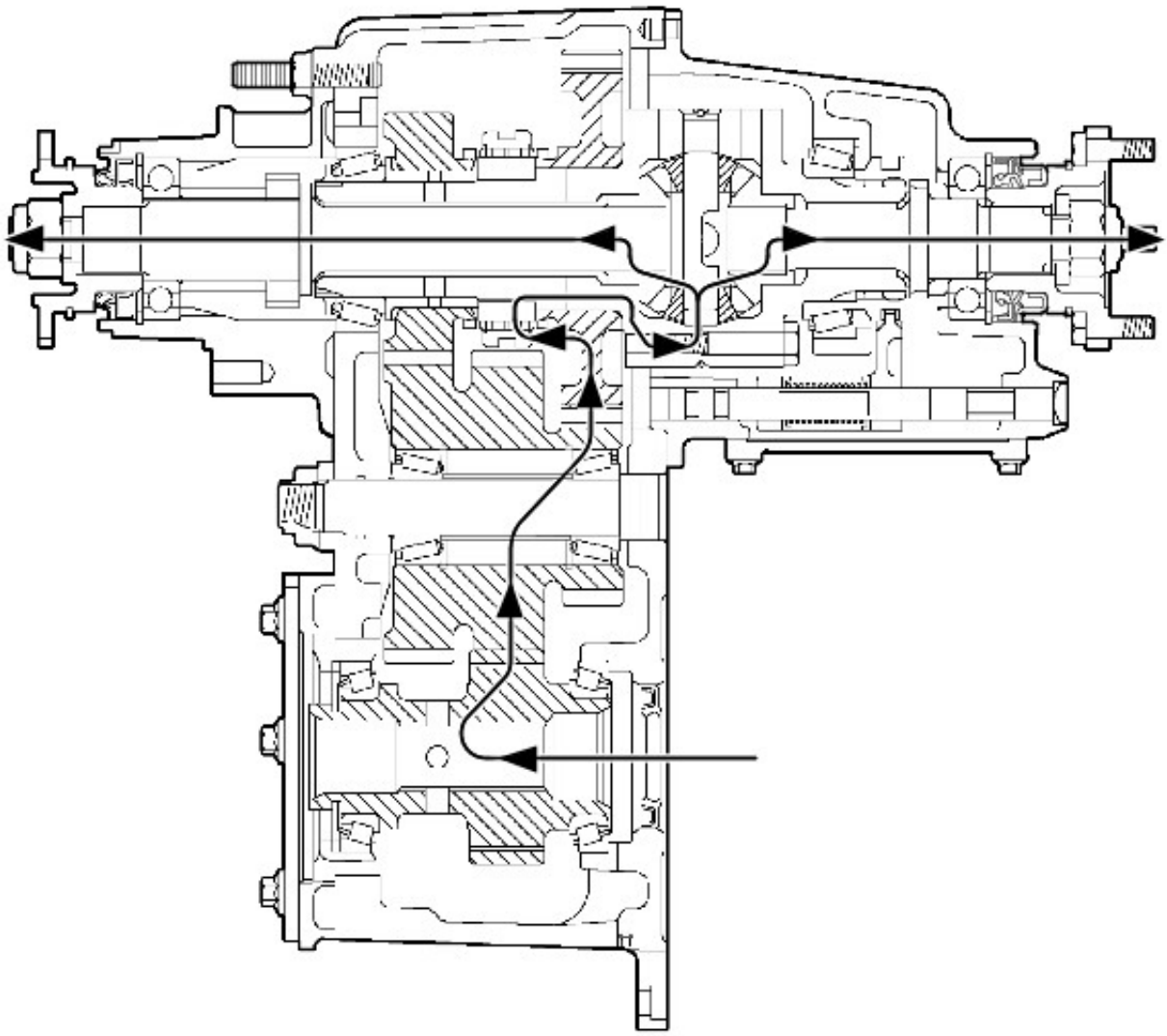
LUBRICATION

Lubrication is by splash, oil filler/level and drain plugs being located in the main casing.

Internal pressures caused by thermal expansion and contraction are avoided by the use of a plastic breather pipe venting the interior of the box to atmosphere. The pipe is attached to the top of the high/low selector housing and is routed in a continuously rising path into the engine compartment where the open end is secured to the engine cylinder block.

OPERATION

Power Flow - Transfer Box in LOW Range



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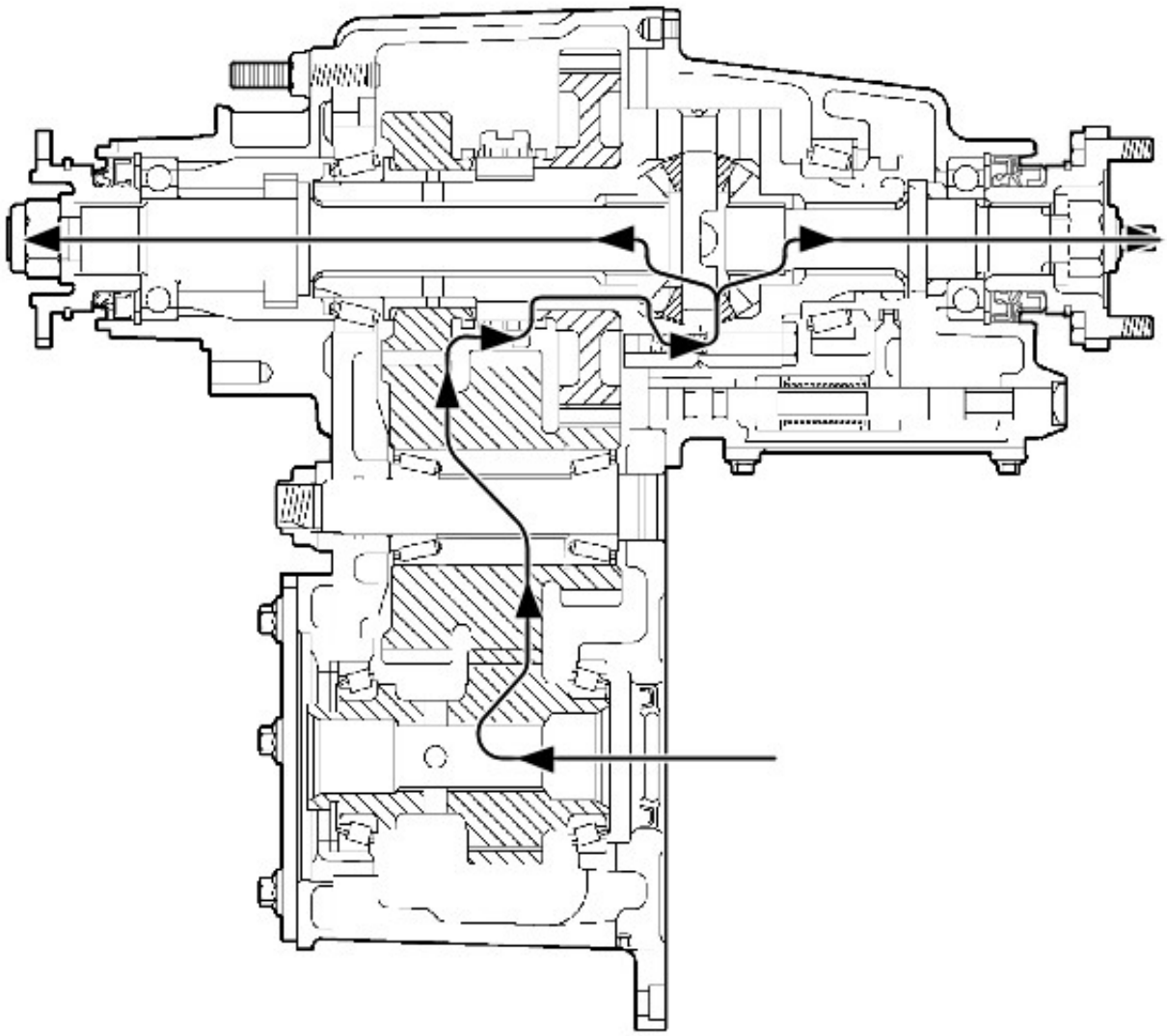
Power Flow - Transfer Box in HIGH Range



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The gearbox output shaft transmits power to the mainshaft input gear which is in constant mesh with one of the intermediate gears. The intermediate gears are in constant mesh with the high and low range output gears running on the differential rear shaft.

Power is transmitted to the output shafts via the differential assembly by locking either the high or low range gears to the differential rear shaft. This is achieved by means of the high/low selector fork, sleeve and splined hub.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Draining and Filling

General Procedures

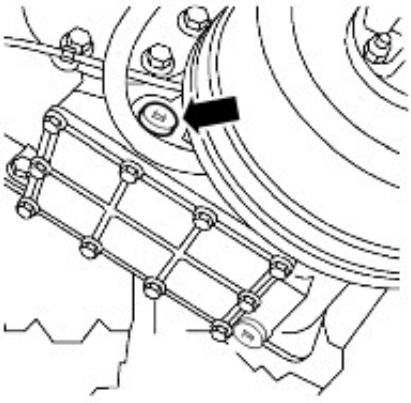
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Position a container to collect the fluid.

3. NOTE: Clean the area surrounding the transfer case filler/level plug.

Remove the transfer case filler plug to vent the transfer case and assist with drainting.



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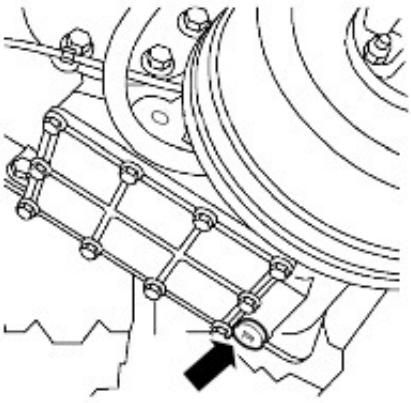
4. NOTE: Clean the area surrounding the transfer case fluid drain plug.

Remove the transfer case fluid drain plug.



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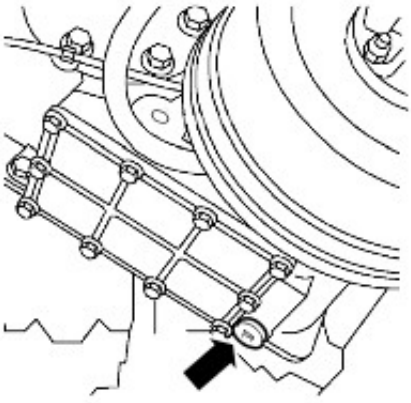
5. Allow the fluid to drain.

6. Install the transfer case drain plug and clean any oil residue from the surrounding area.

- Tighten to 30 Nm (22 lb.ft).

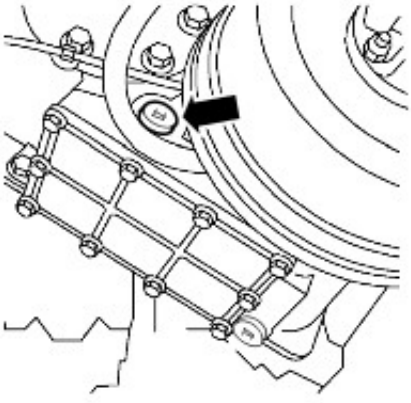


E91242

7. CAUTION: The transfer case oil filler plug must not be used as a transfer case oil level plug. Failure to follow this instruction may result in damage to the vehicle.

Refill the transfer case with the recommended fluid.
For additional information, refer to: Specifications (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Specifications).

8. Install the transfer case filler plug and clean any oil residue


E91241

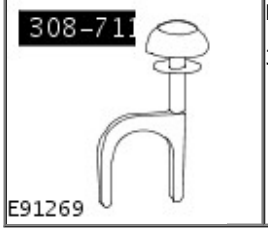
from the surrounding area.

- Tighten to 30 Nm (22 lb.ft).

9. Remove the container.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case High/Low Range Selector Rod Adjustment

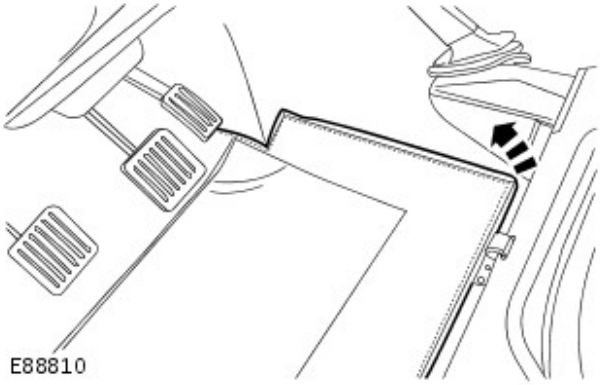
General Procedures

Special Tool(s)	
	Locking Tool High/Low Selector 308-711

• NOTE: If carrying out this procedure after replacing the transfer case high/low range selector linkage, carry out steps 13 - 19.

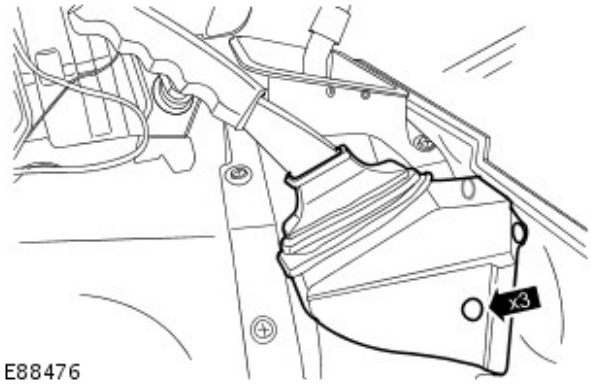
1. Remove the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

2. Reposition the LH carpet.



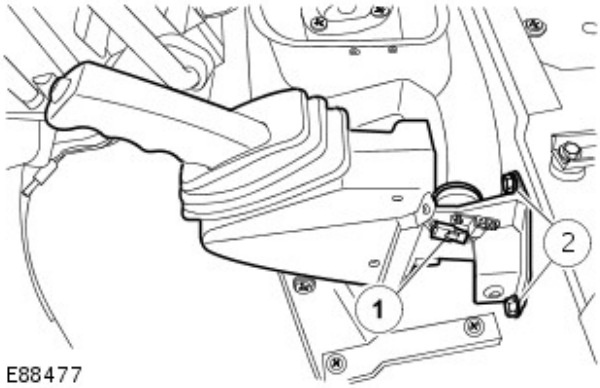
3. Remove the parking brake lever gaiter.

- Remove the 3 clips.

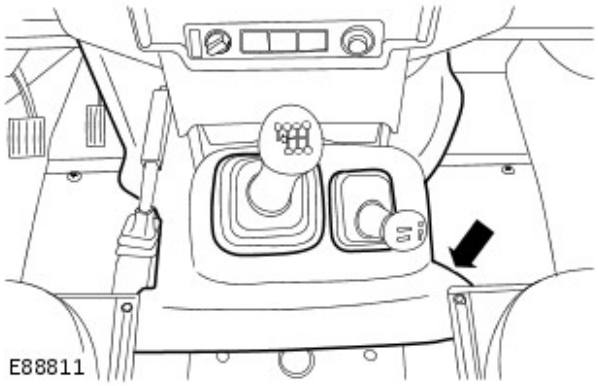


4. Release the parking brake lever.

1. Disconnect the electrical connector.
2. Remove the 2 bolts.

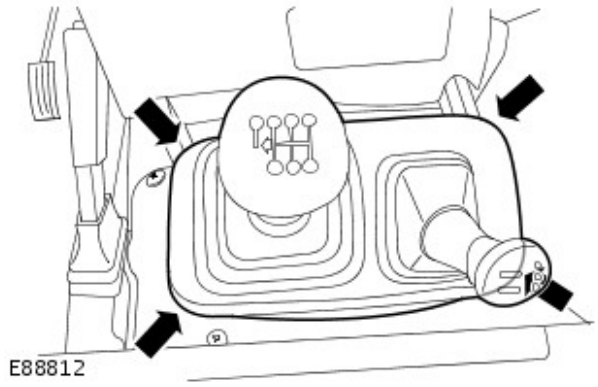


5. Remove the transmission cover panel floor covering.



6. NOTE: Do not detach the gaiter from the selector knobs.

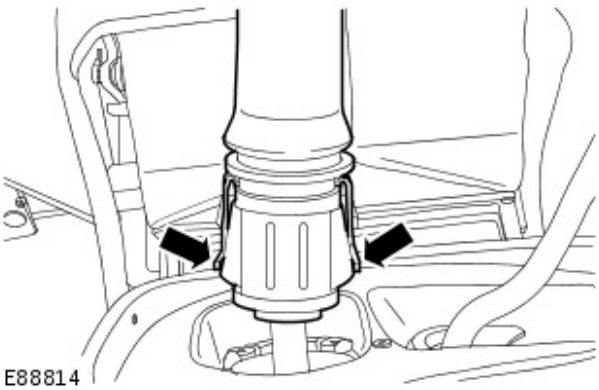
Detach the gaiter from the transmission cover panel.



7. WARNING: The gearshift lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Release the gearshift lever knob.

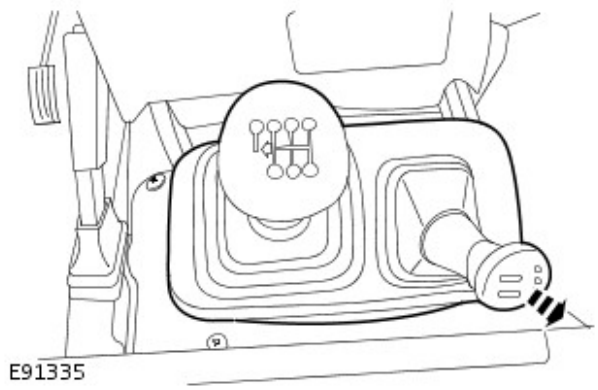
- Release the 2 clips.



8. WARNING: The high/low range selector lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

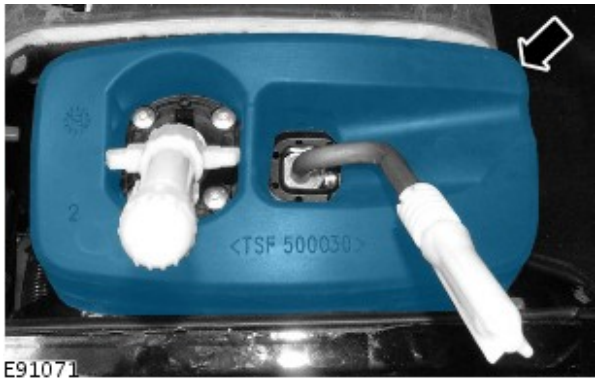
Remove the gaiter and selector levers.

- Detach the high/low range selector lever.



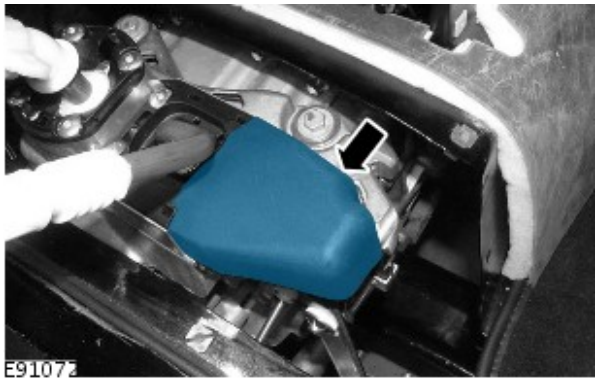
9. Remove the transmission cover panel.

- Remove the 11 screws.

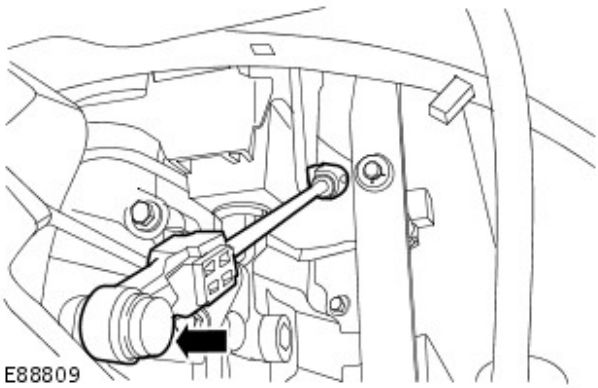


10. NOTE: Position the differential lock to the left, to reduce tension on the insulation.

Remove the insulation pad.

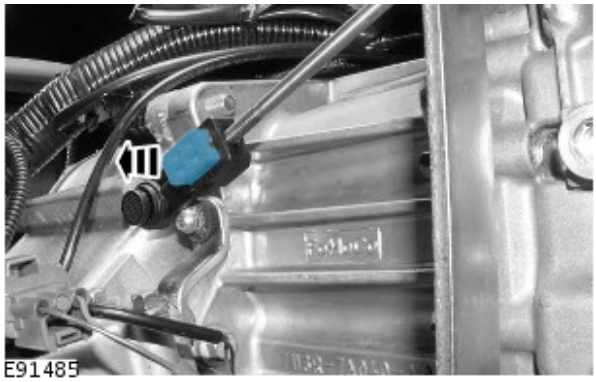


11. Remove the insulation pad support bracket.



12. Disconnect the transfer case high/low range selector rod.

- Press the button to release the transfer case high/low range selector rod.



13. Release the adjuster.

- Release the locking block.

14. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

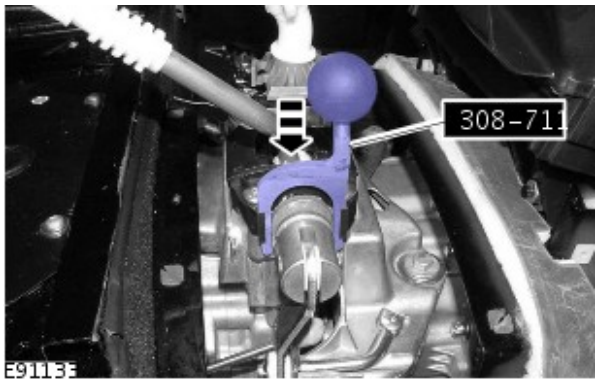
Raise and support the vehicle.

15. NOTE: It may be necessary to rotate the road wheels to confirm that high range is fully engaged.

Make sure that high range is fully engaged on the transfer case.

16. Using the special tool, set the transfer case high/low range selector lever in high range.

- Insert the special tool.

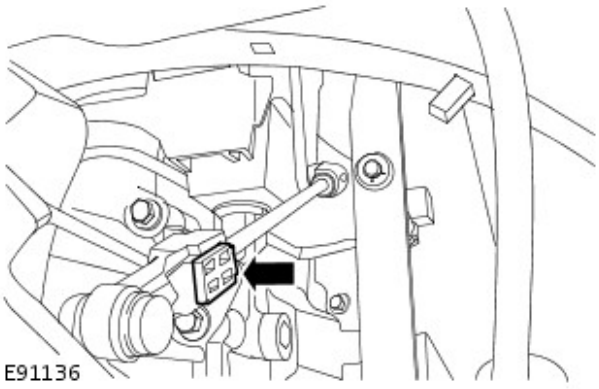


17. NOTE: Make sure the transfer case high/low range selector rod is fully engaged on the ball joint and not the foam washer.

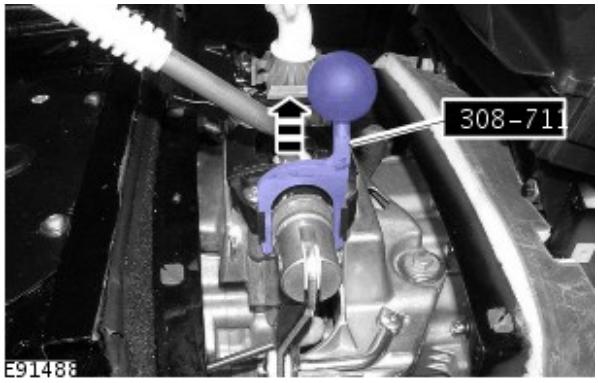
Connect the transfer case high/low range selector rod.

18. Push in the locking block.

- Fully engage the locking block.



19. Remove the special tool.



20. Install the insulation pad support bracket.

21. NOTE: Position the differential lock to the left, to reduce tension on the insulation.

Install the insulation pad.

22. Install the transmission cover panel.

- Install the screws.

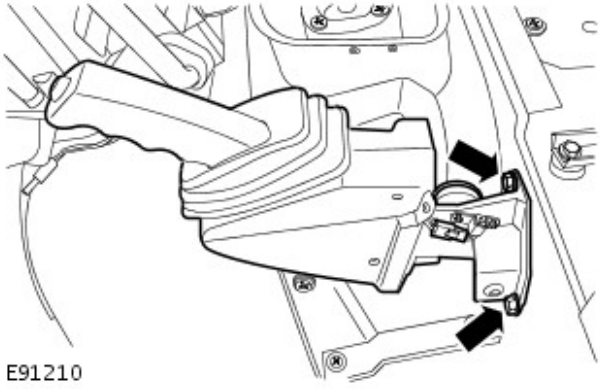
23. Install the gaiter with the selector levers attached.

- Install the selector levers.
- Fully seat the gaiter.

24. Install the transmission cover panel floor covering.

25. Install the parking brake lever.

- Tighten to 25 Nm (18 lb.ft).



26. Install the parking brake lever gaiter.

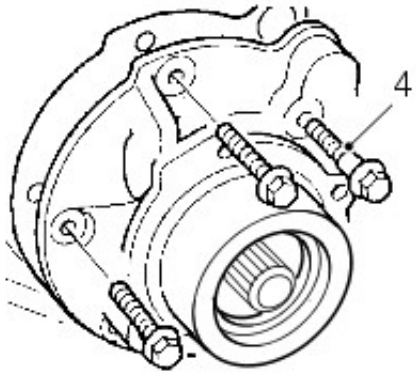
- Install the clips.

27. Reposition the LH carpet.

28. Install the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Extension Housing

In-vehicle Repair



M417563

Removal

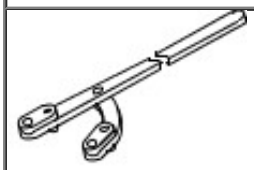
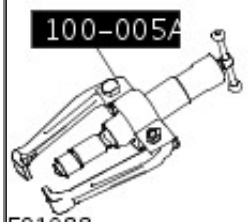
1. Drain transfer case oil.
   For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
2. Remove transfer case rear output shaft seal.
   For additional information, refer to: Transfer Case Rear Output Shaft Seal (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
3. Mark extension housing to main casing for assembly purposes.
4. Note position of shoulder bolt, remove 6 bolts securing extension housing to main casing.

Installation

1. Clean extension housing, mating face on main casing and sealant from bolt threads.
2. Apply sealant, Part No. STC 4600 to mating flange on output shaft housing.
3. Fit extension housing to main casing ensuring that splines of output shaft are engaged in differential.
4. Apply sealant, Part No. STC 50552 to bolt threads.
5. Fit bolts and tighten by diagonal selection to 45 Nm (33 lbf.ft).
6. Fit transfer case rear output shaft seal. For additional information, refer to: Transfer Case Rear Output Shaft Seal (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, In-vehicle Repair).
7. Fill transfer case with oil.
   For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Front Output Shaft Seal

In-vehicle Repair

Special Tool(s)	
 205053	Output Shaft Flange Holding Tool 205-053
 E91088	General Purpose Puller 100-005A
E91089	Replacer, Oil Seal 307-479

Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

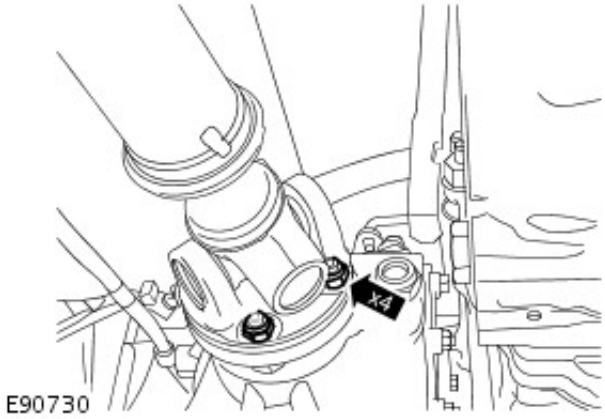
Raise and support the vehicle.

2. Drain the transfer case.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

3. NOTE: Mark the front driveshaft to transfer case drive flange.

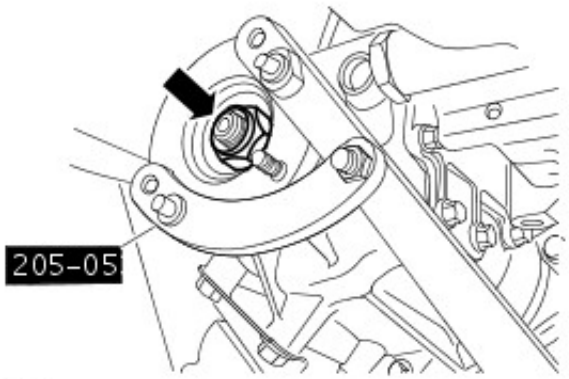
Release the driveshaft from the transfer case output drive flange.

- Remove and discard the 4 nuts.



E90730

4. Using the special tool, restrain the transfer case front



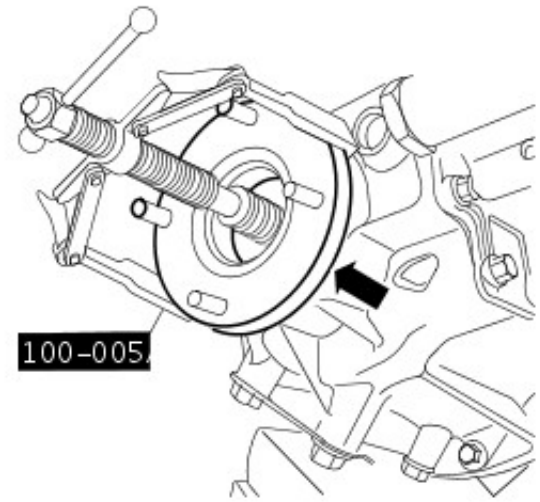
E90755

output flange.

- Remove and discard the nut and felt washer.

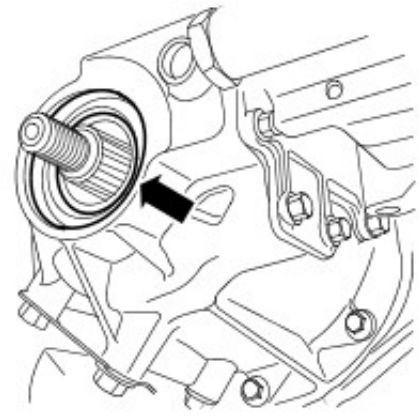
5. Remove the transfer case front output flange.

- If necessary use the special tool to remove the transfer case front output flange.



E90756

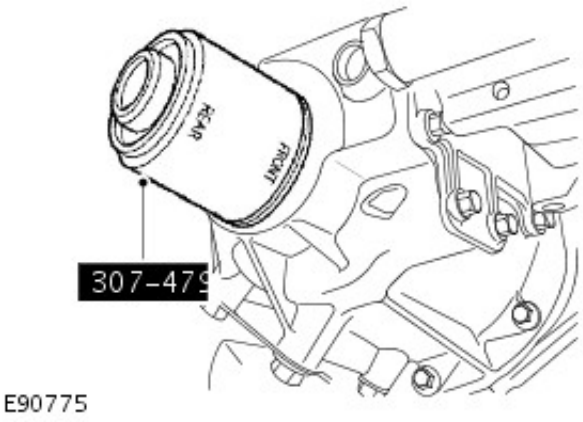
6. Using a suitable tool, remove and discard the transfer case front output shaft seal.



E90757

Installation

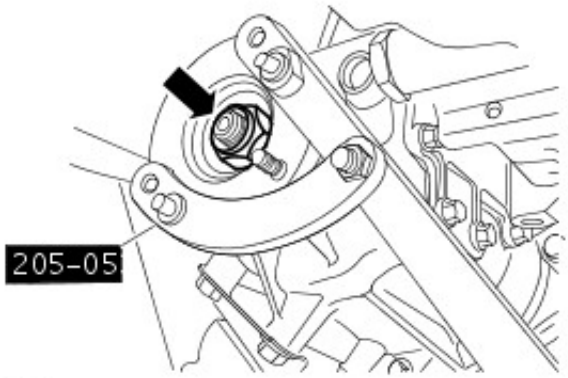
1. NOTE: Clean the component mating faces.



E90775

- NOTE: Use end of tool marked 'FRONT' to fit seal.

Using the special tool, install a new transfer case front output shaft seal.

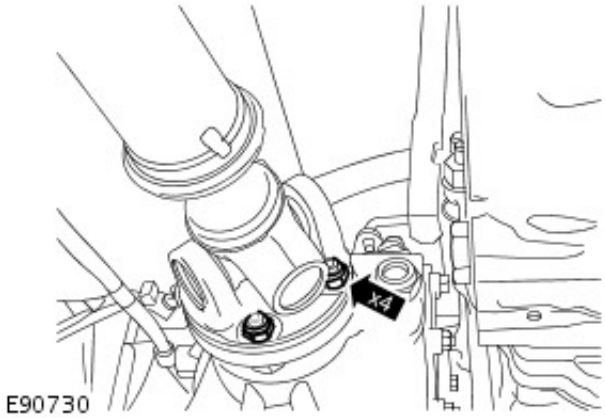


E90755

2. NOTE: Install a new felt washer.

Install the transfer case front output flange.

- Install the washer.
- Install a new nut and tighten to 162 Nm (120 lb.ft).



E90730

3. NOTE: Install new nuts.

Tighten to 45 Nm (33 lb.ft).

- Align the position of the driveshaft in relation to the drive pinion flange.

4. Fill the transfer case.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

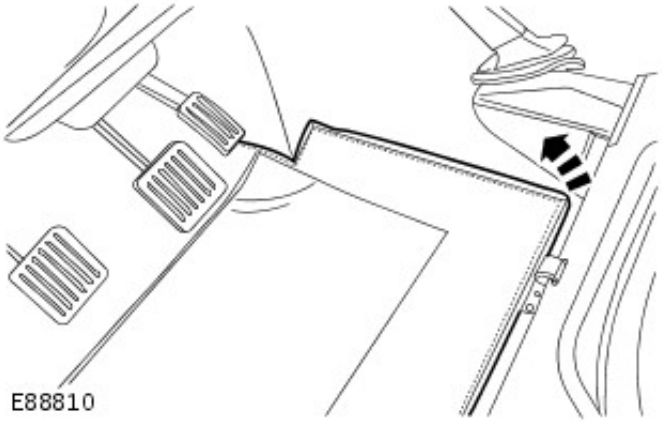
Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case High/Low Range Linkage

In-vehicle Repair

Removal

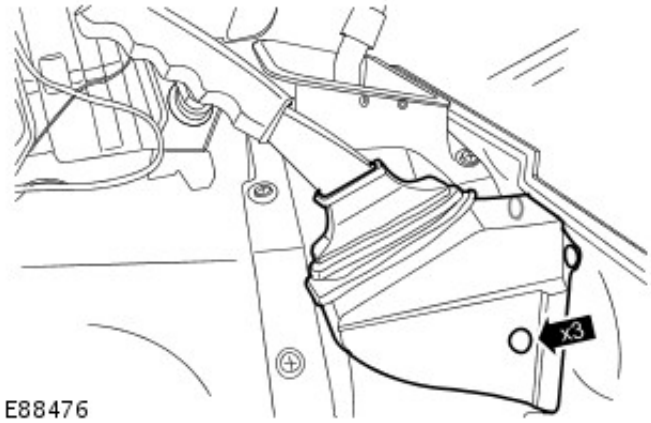
1. Remove the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

2. Reposition the LH carpet.



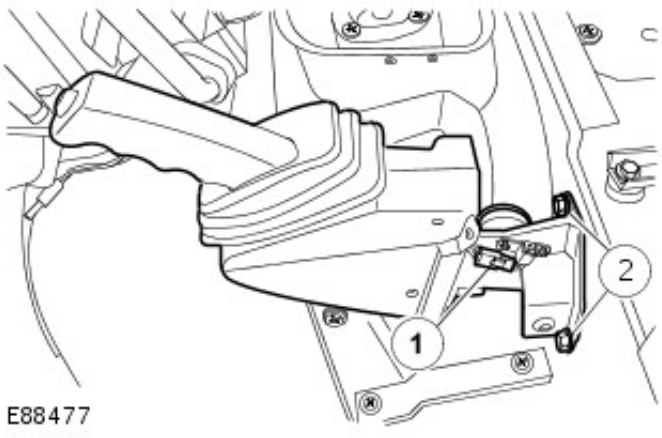
3. Release the parking brake lever gaiter.

- Remove the 3 clips.

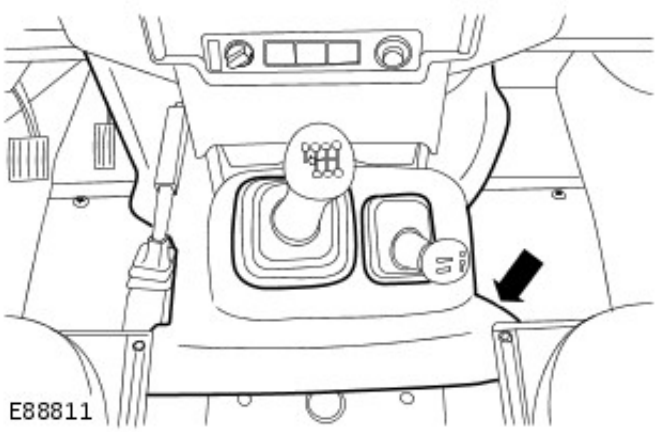


4. Release the parking brake lever.

1. Disconnect the electrical connector.
2. Remove the 2 bolts.

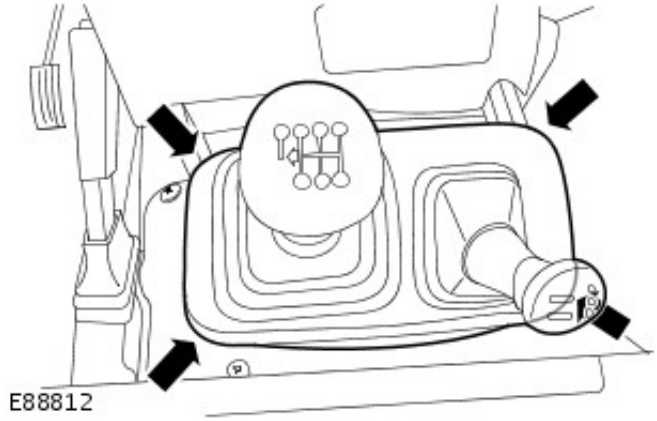


5. Remove the transmission cover panel floor covering.



6. NOTE: Do not detach the gaiter from the selector knobs.

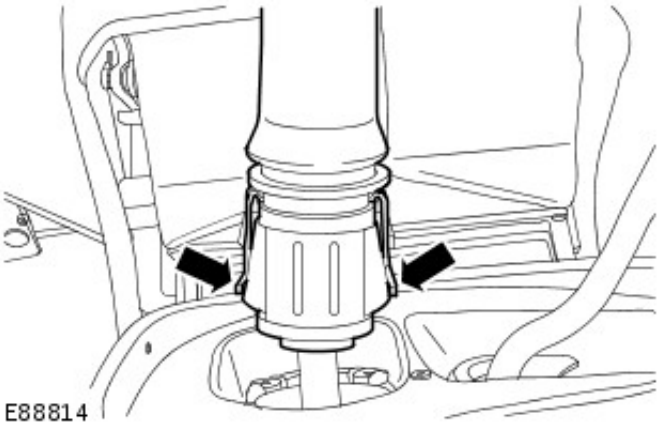
Detach the gaiter from the transmission cover panel.



7. WARNING: The gearshift lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Release the gearshift lever knob.

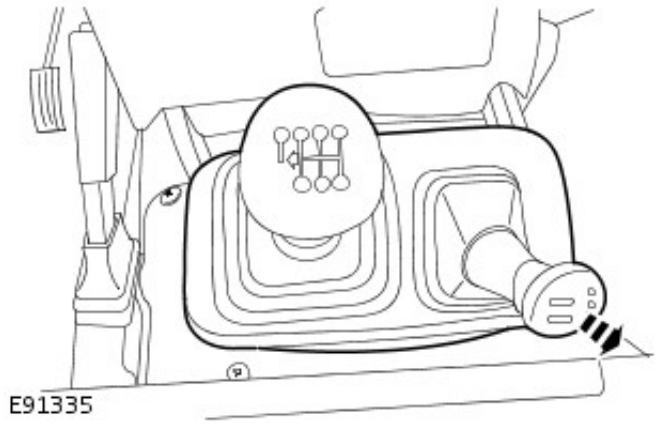
- Release the 2 clips.



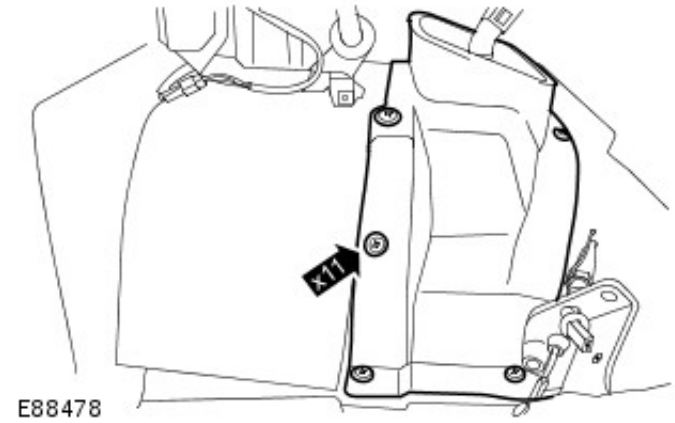
8. WARNING: The high/low range lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Remove the gaiter and selector levers.

- Detach the high/low range selector lever.



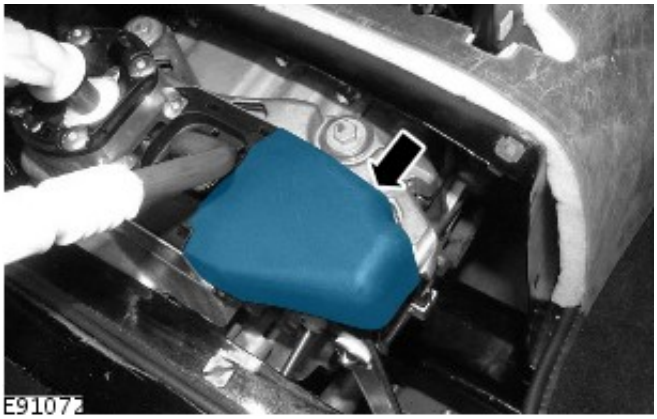
9. Remove the transmission cover panel.



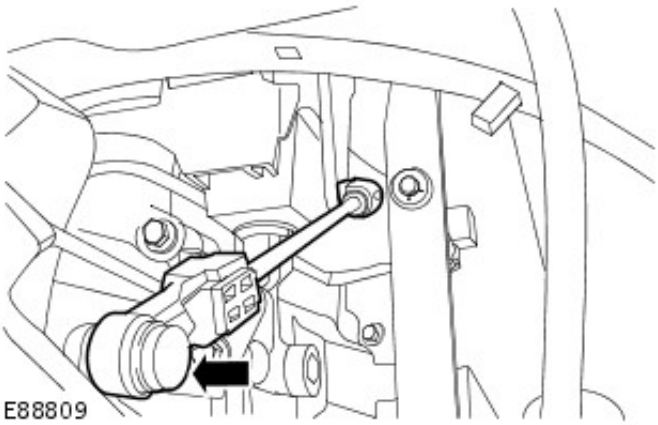
- Remove the 11 screws.

10. NOTE: To reduce tension on the insulation, position the differential lock lever to the left.

Remove the insulation pad.



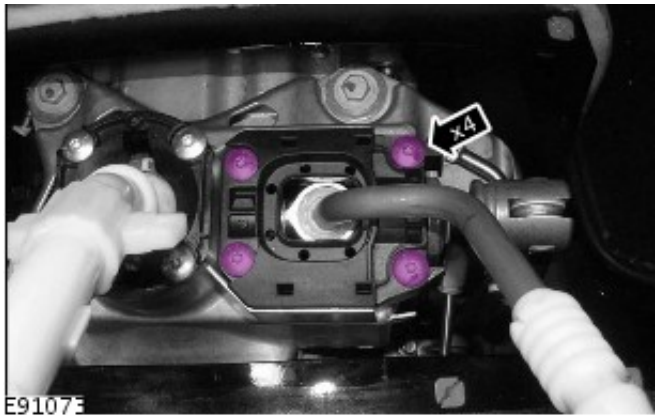
11. Remove the insulation pad support bracket.



12. Disconnect the high/low range selector rod.

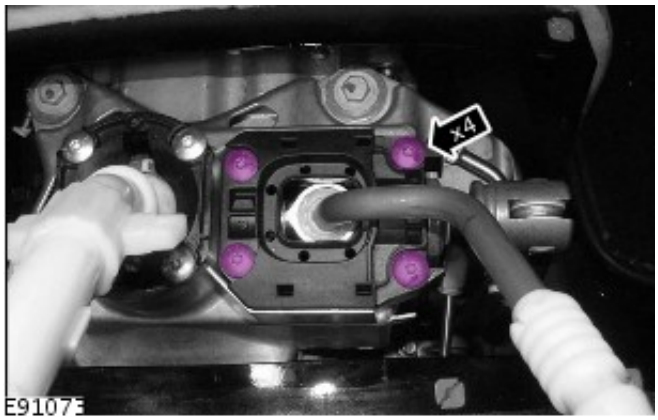
- Press the button to release the fitting before disconnecting the rod.

13. Remove the high/low range linkage.



- Remove the 4 screws.

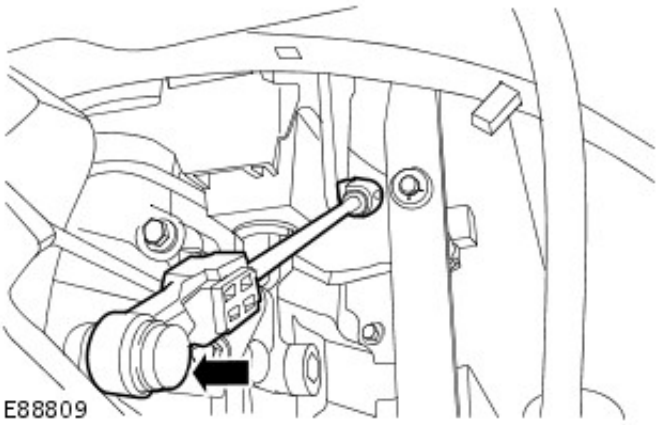
Installation



1. Install the high/low range linkage.

- Tighten to 7 Nm (5 lb.ft).

• NOTE: If adjustment of the transfer case high/low range selector linkage has changed, carry out the adjustment procedure.
For additional information, refer to: Transfer Case High/Low Range Selector Rod Adjustment (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).



2. NOTE: Make sure the rod is fully engaged on the ball joint and not on the foam washer.

Connect the high/low range selector rod.

3. Install the insulation pad support bracket.

4. NOTE: Position the differential lock to the left, to reduce tension on the insulation.

Install the insulation pad.

5. Install the transmission cover panel.

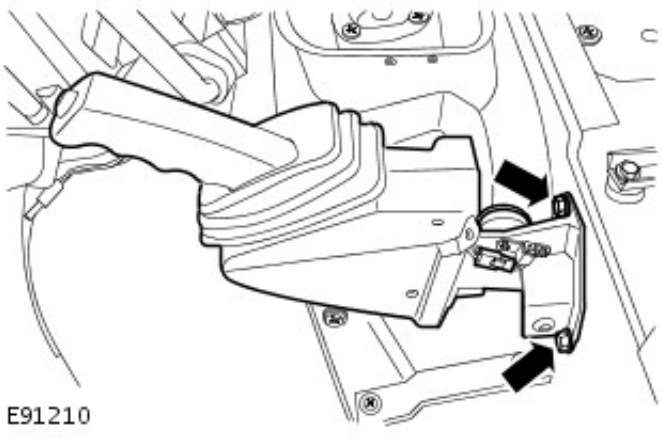
- Install the screws.

6. Install the gaiter with the selector levers attached.

- Install the selector levers.
- Fully seat the gaiter.

7. Install the transmission cover panel floor covering.

8. Install the parking brake lever.



- Tighten to 25 Nm (18 lb.ft)

9. Install the parking brake lever gaiter.

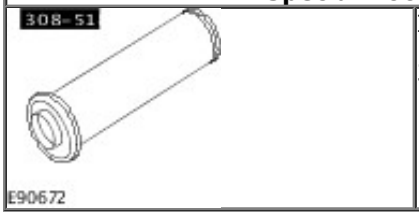
- Install the clips.

10. Reposition the LH carpet.

11. Install the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Input Shaft Seal

In-vehicle Repair

Special Tool(s)	
	Installer, seal 308-518

Removal

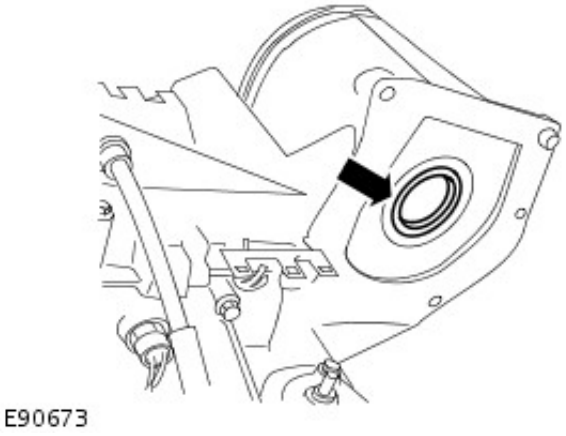
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

   Raise and support the vehicle.

3. Remove transfer case.
   For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal).

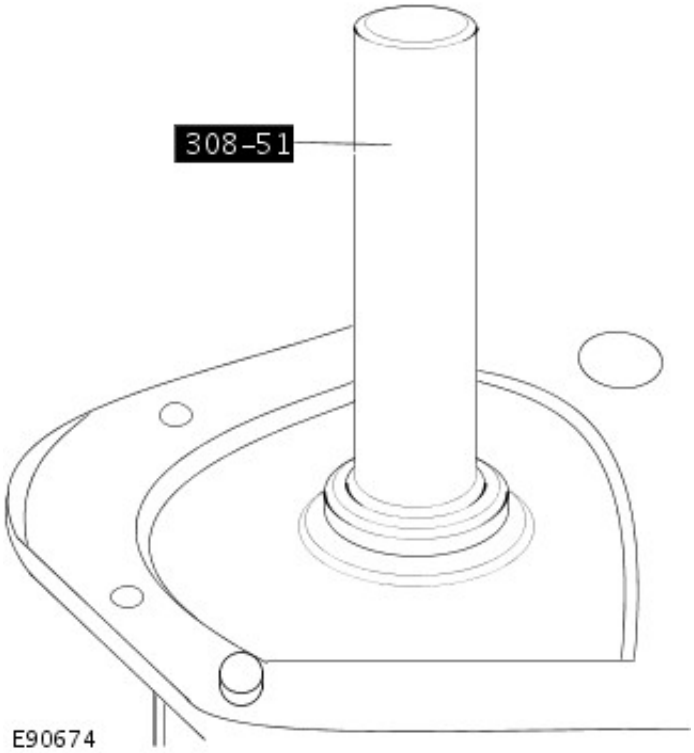
4. Remove and discard the transfer case input shaft seal.



Installation

1. Using the special tool, install a new transfer case input

shaft seal.



2. Install the transfer case.
For additional information, refer to: Transfer Case (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Installation).

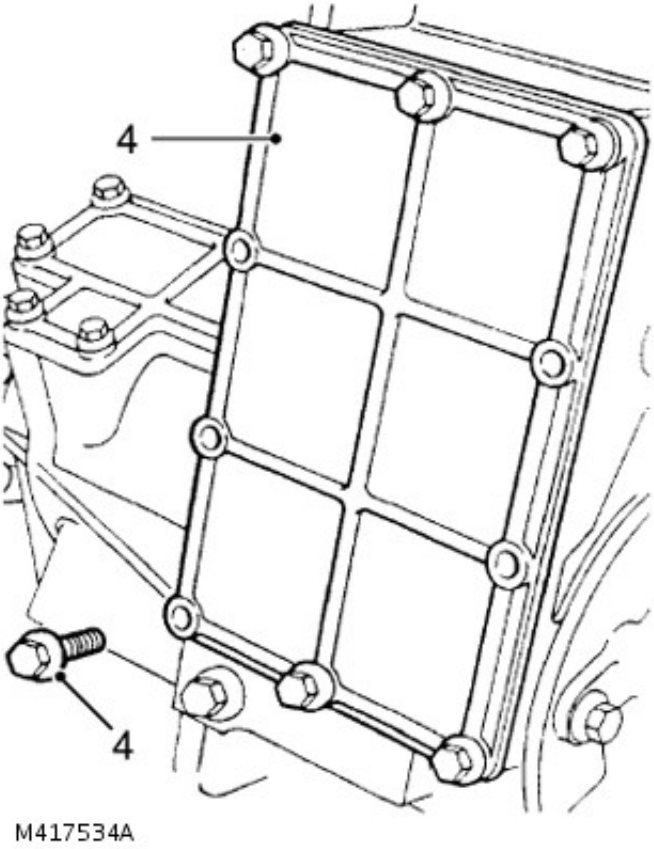
3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Lower Cover

In-vehicle Repair

Removal

1. Raise vehicle on ramp.
2. Drain transfer case oil.
   For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
3. Remove 10 bolts securing lower cover to transfer case and remove cover.



Installation

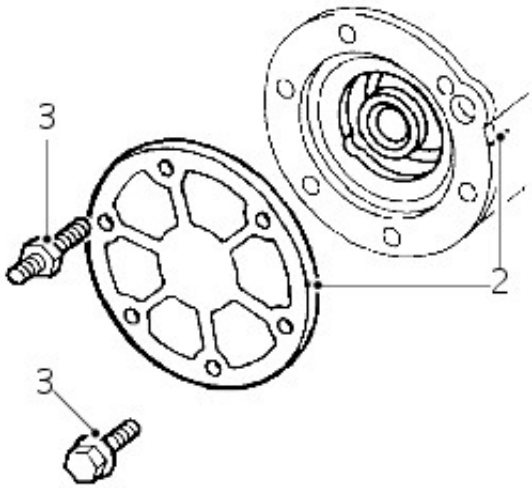
1. Clean lower cover and mating face on transfer case.
2. Clean bolt threads.
3. Apply sealant, Part No. STC 50552 to bolt threads.
4. Apply sealant, Part No. STC 4600 to lower cover sealing face.
5. Position lower cover, fit bolts and tighten to 25 Nm (18 lbf.ft).
6. Fill transfer case with oil.
   For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
7. Lower vehicle on ramp.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Rear Cover

In-vehicle Repair

Removal

1. Raise vehicle on 4 post ramp.
2. Mark rear cover to bearing housing for assembly purposes.
3. Noting fitted position of stud bolt and harness clip bracket, remove 5 bolts and stud bolt securing rear cover.



M417547

4. Collect harness clip bracket.
5. Remove rear cover.

Installation

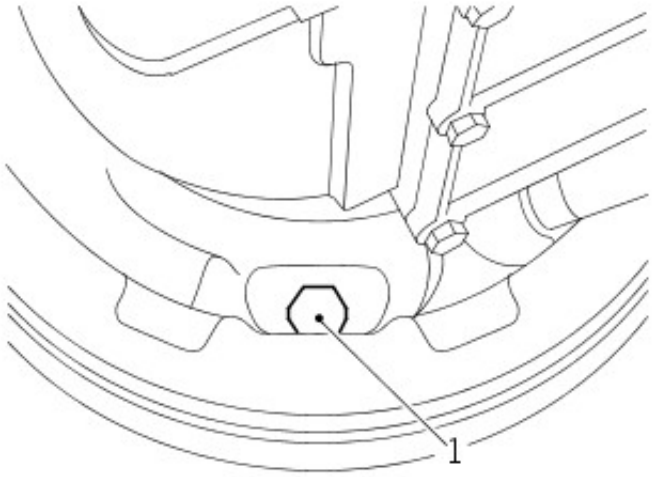
1. Clean rear cover and mating face.
2. Apply sealant, Part No. STC 4600 to rear cover mating face.
3. Align reference marks, fit rear cover.
4. Clean rear cover bolts and apply sealant, Part No. STC 50552 to threads of bolts and stud nut.
5. Position clip bracket, fit stud nut and bolts, tighten by diagonal selection to 25 Nm (18 lbf.ft).
6. Check/top-up transfer case oil.
   For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
7. Lower vehicle.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case Rear Output Shaft Seal

In-vehicle Repair

Removal

1. Loosen brake shoe adjuster bolt.



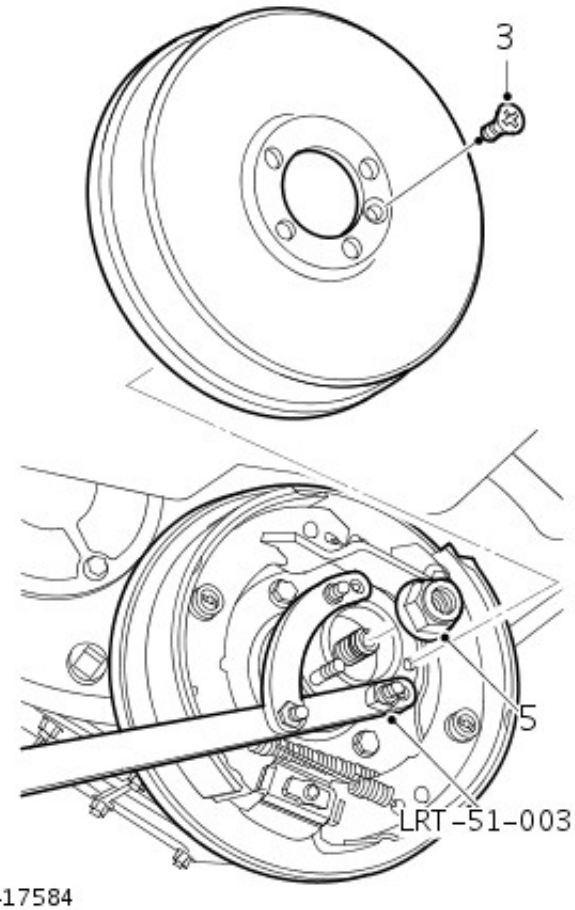
M417785

2. Remove rear drive shaft.
For additional information, refer to: Rear Driveshaft (205-01 Driveshaft, Removal and Installation).

3. Remove screw securing brake drum.

4. Remove brake drum.

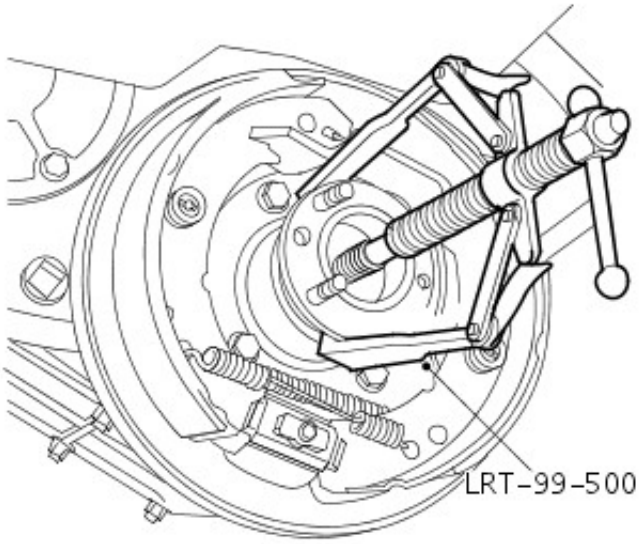
5. Restrain transfer case drive flange using LRT-51-003, remove and discard drive flange nut, remove and discard steel and felt washers.



M417584

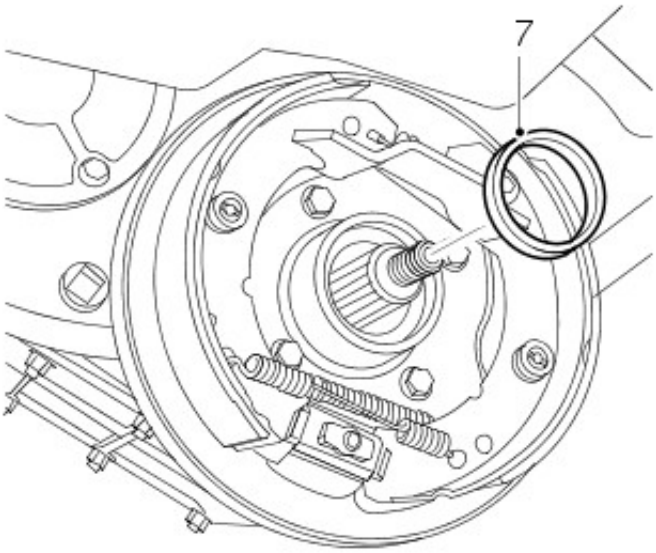
6. Using LRT-99-500 if necessary, remove drive flange from

transfer case.



M417585

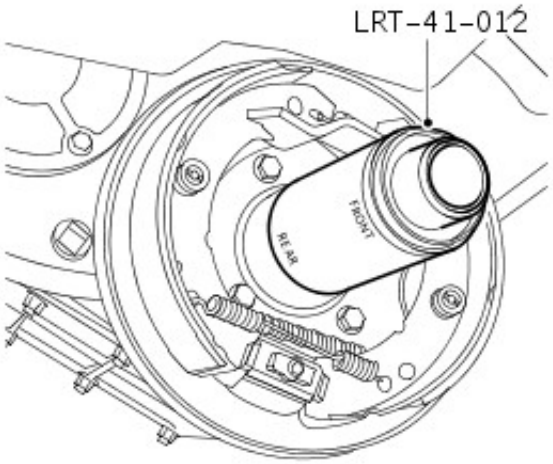
7. Remove and discard rear output shaft oil seal from transfer case.



M417586

Installation

1. Clean seal recess.



M417744

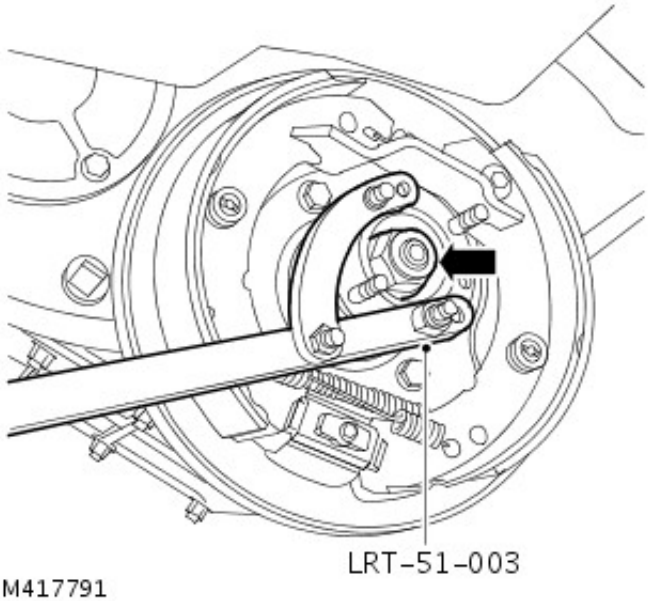
- NOTE: Use end of tool marked 'REAR' to instal seal.

2. CAUTION: Oil seal must be fitted dry.

Install new seal using LRT-41-012 .

3. Position drive flange, instal new felt and steel washers.

4. Position LRT-51-003 instal and tighten new drive flange nut to 148 Nm (109 lbf.ft).



M417791

5. Position brake drum and tighten screw.

6. Tighten adjuster bolt to 25 Nm (18 lbf.ft) then back off 1 ½ turns.

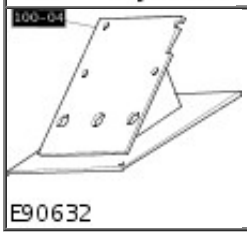
7. Check that brake drum is free to rotate.

8. Install drive shaft.
For additional information, refer to: Rear Driveshaft (205-01 Driveshaft, Removal and Installation).

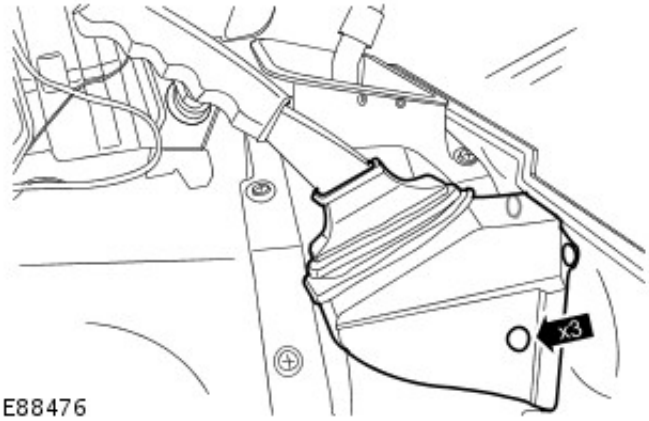
9. Top-up transfer case oil.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case

Removal

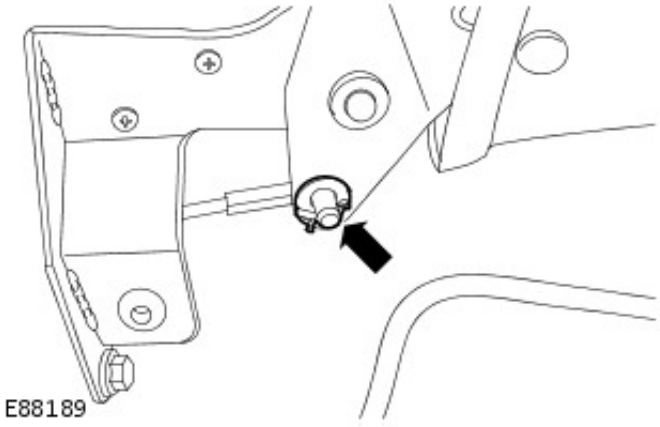
Special Tool(s)	
	Power train Assembly Jack HTJ1200-02
	Transfer Case Support 100-045

Removal



1. Release the parking brake lever gaiter.

- Release the 3 clips.



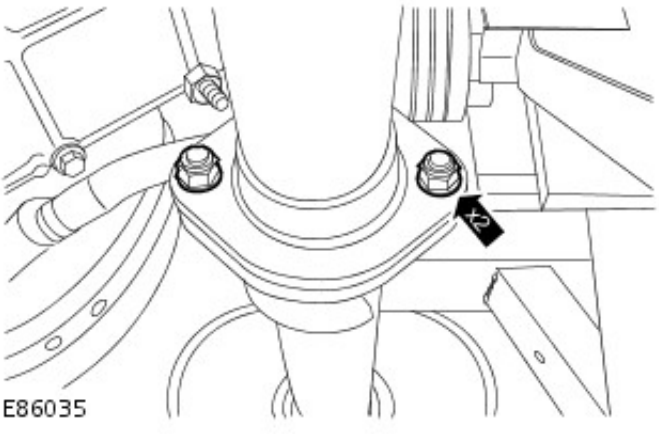
2. Remove the parking brake lever clevis pin.

- Remove the pin.

3. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

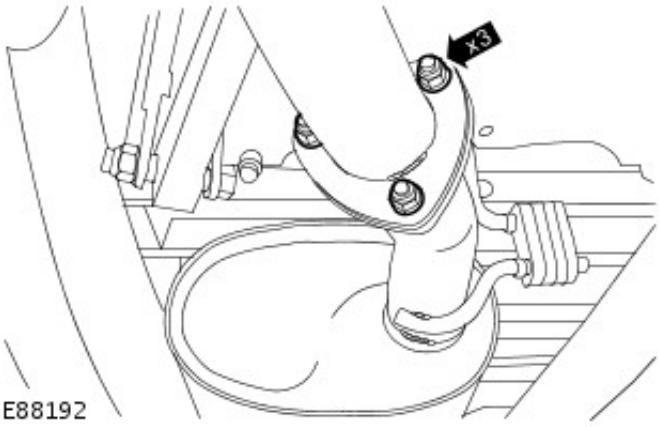
Raise and support the vehicle.

4. Release the intermediate pipe from the catalytic converter.



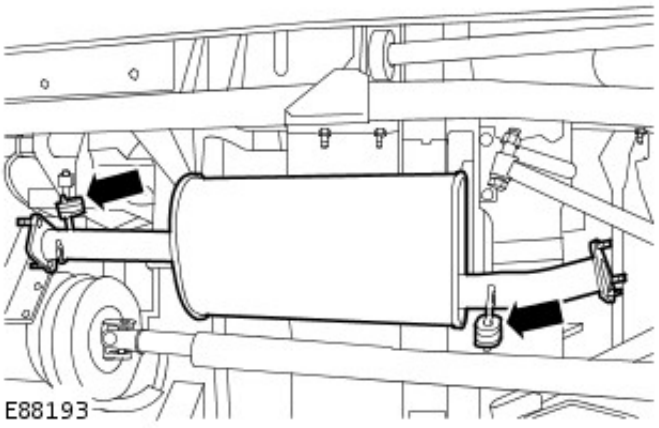
- Remove and discard the 2 nuts.

5. Release the tail pipe from the intermediate pipe.



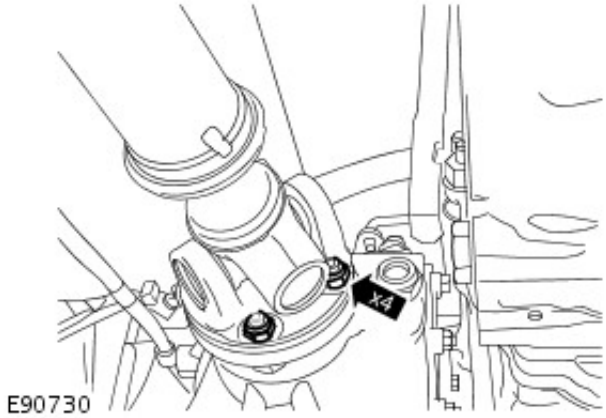
- Remove and discard the 3 nuts.
- Remove and discard the gasket.

6. Remove the intermediate pipe and muffler.



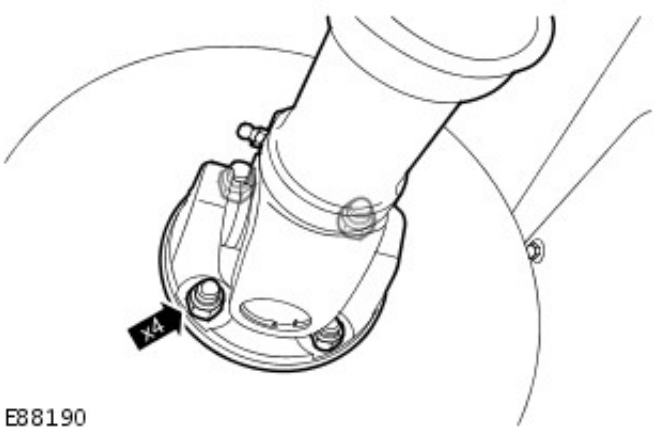
7. NOTE: Mark the front driveshaft to transfer case drive flange.

Remove and discard the 4 nuts.



- Using a suitable tie strap, secure the driveshaft to one side.

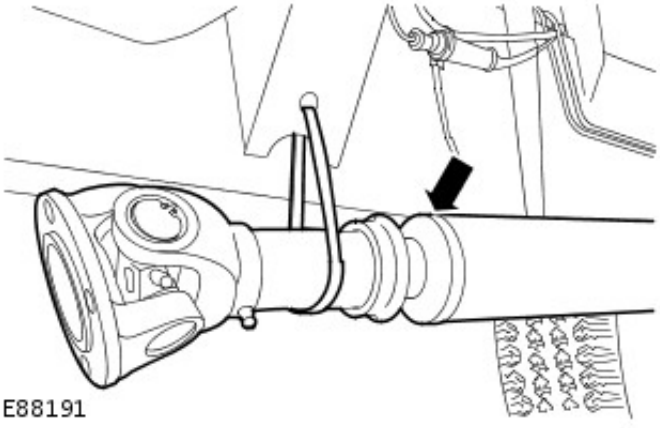
8. Remove the 4 nuts from the rear driveshaft to transfer



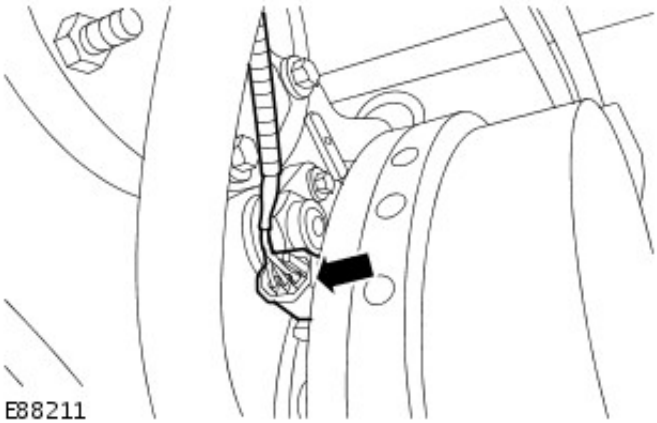
E88190

case.

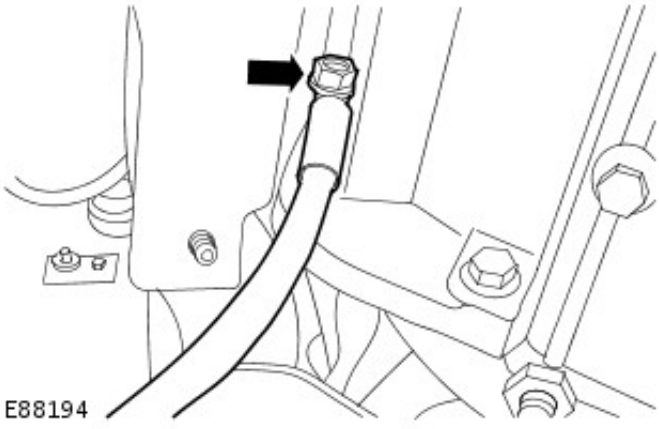
- Mark the position of the driveshaft in relation to the drive pinion flange.


E88191

9. Using a suitable tie strap, secure the rear driveshaft to the chassis.


E88211

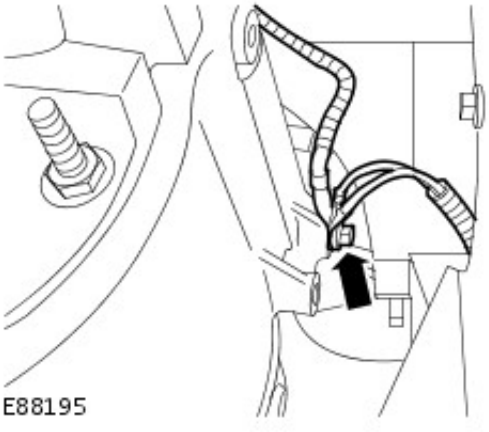
10. Disconnect the electronic speedometer electrical connector from the transfer case.


E88194

11. Disconnect the LH earth cable from the transfer case.

- Remove the nut.

12. Disconnect the RH earth cables from the transfer case.

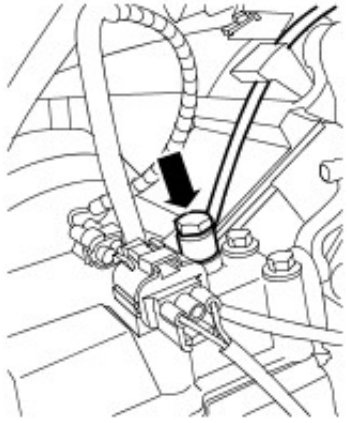

E88195

- Remove the bolt.

13. NOTE: Make sure that all openings are sealed. Use new blanking caps.

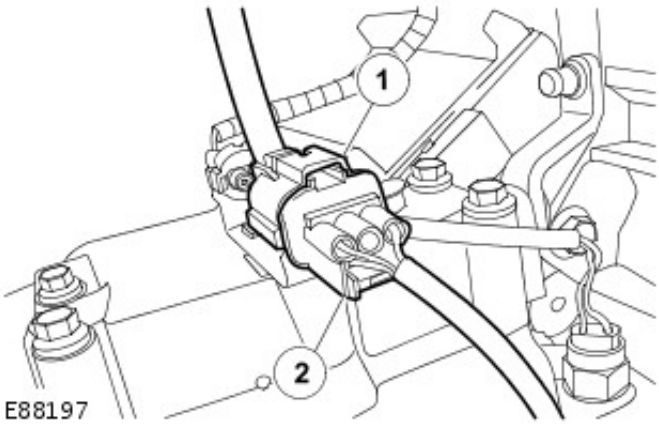
Remove the transfer case breather pipe bolt.

- Remove and discard the sealing washers.


E88196

14. Disconnect the transmission range selector warning lamp electrical connector.

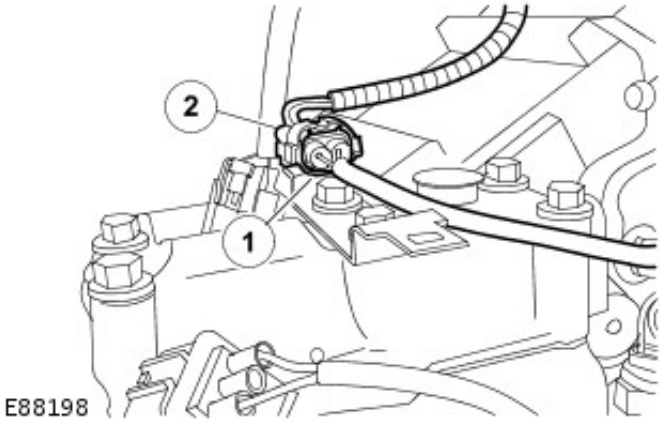
1. Disconnect the electrical connector.
2. Release the electrical connector from the bracket.



E88197

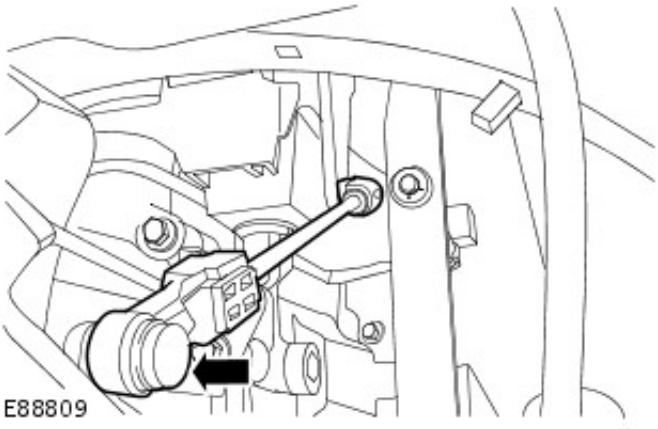
15. Disconnect the differential lock detection switch electrical connector.

1. Disconnect the electrical connector.
2. Release the electrical connector from the bracket.



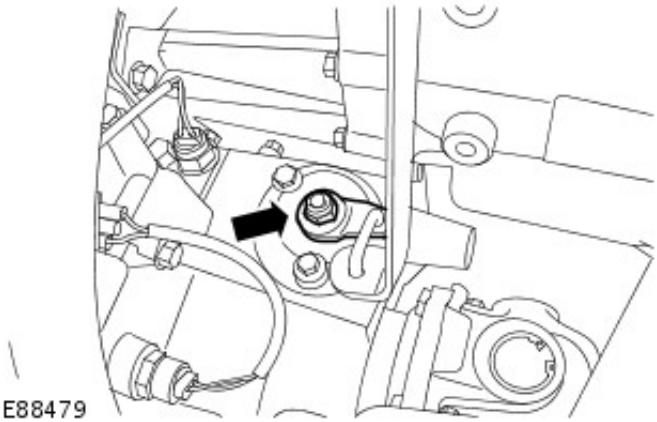
E88198

16. Disconnect the transmission range selector rod.



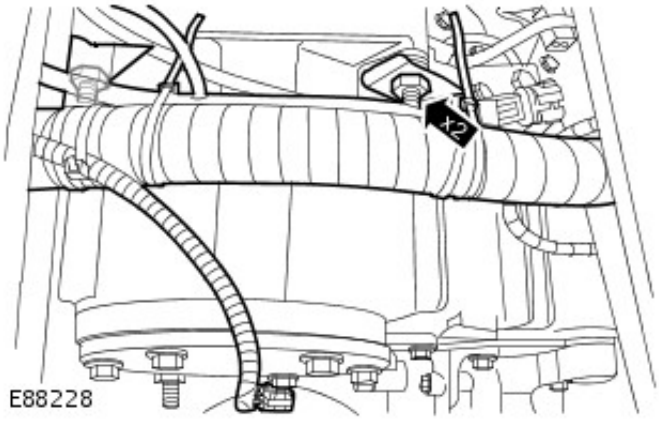
- Press the button to release the fitting before disconnecting the rod.

17. Remove the retaining clip at the lower end of the pivot arm.



18. Remove the differential lock control operating rod.

- Remove the nut.

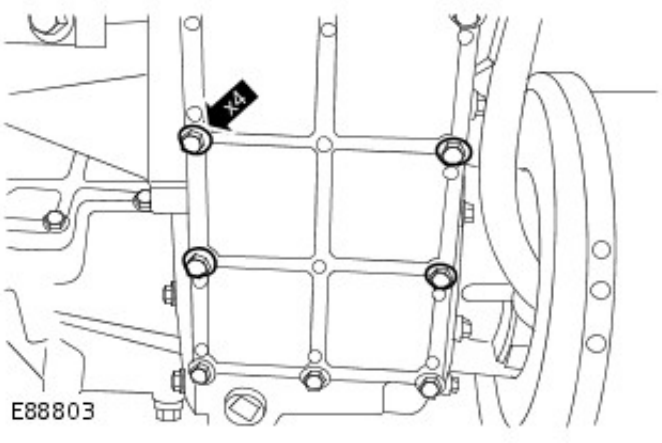


19. Release the transmission wiring harness.

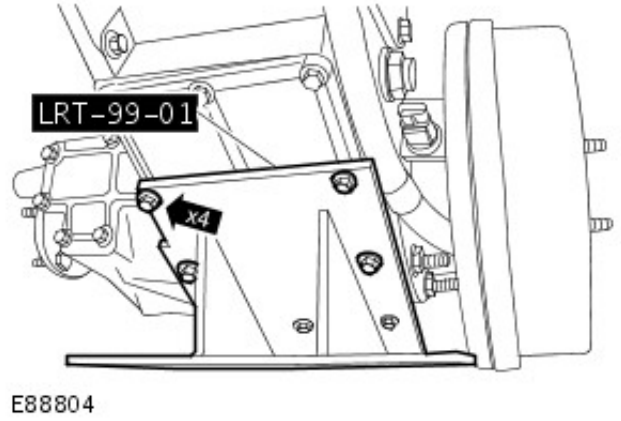
- Remove the nut and bolt.

20. Drain the transfer case.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

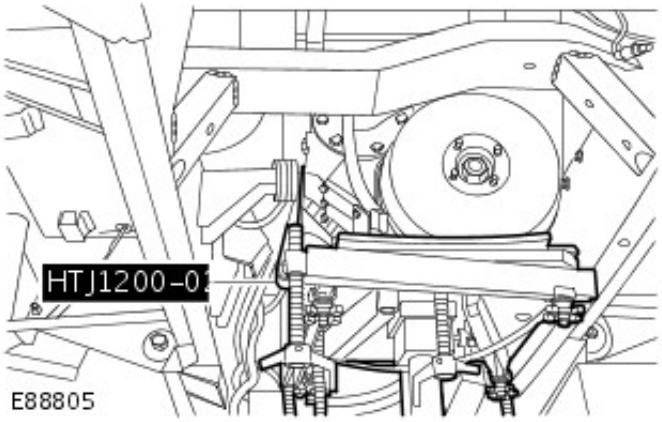
21. Remove the 4 bolts.



22. Install the special tool.



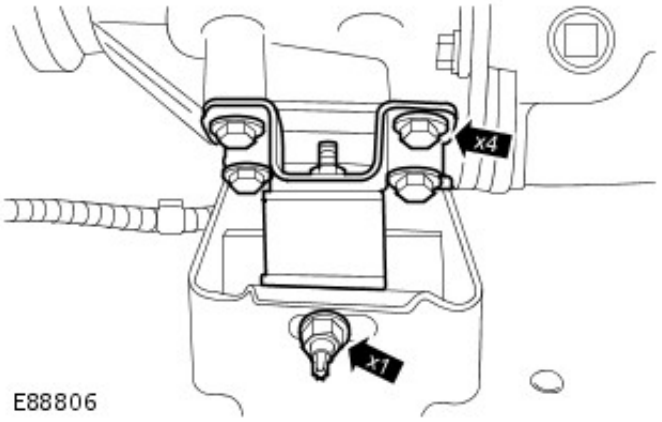
23. Install the special tool.



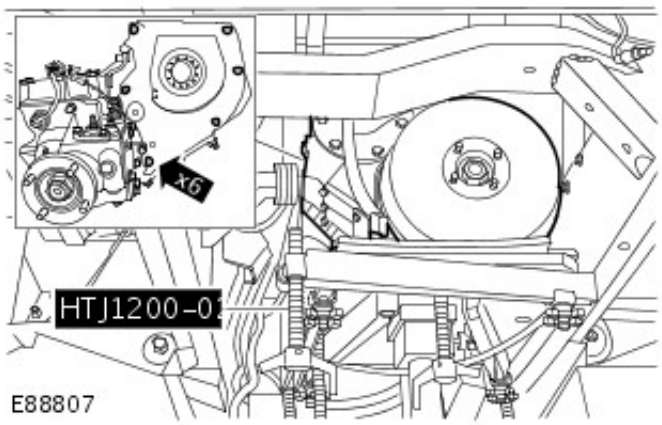
24. NOTE: Raise the transmission jack.

Remove the right-hand transfer case mount.

- Remove the 4 bolts.
- Remove the nut.



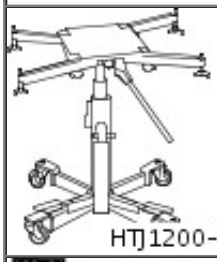
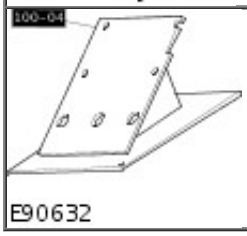
25. With assistance, remove the transfer case.



- Remove the 4 bolts.
- Remove the 2 nuts.

Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Transfer Case

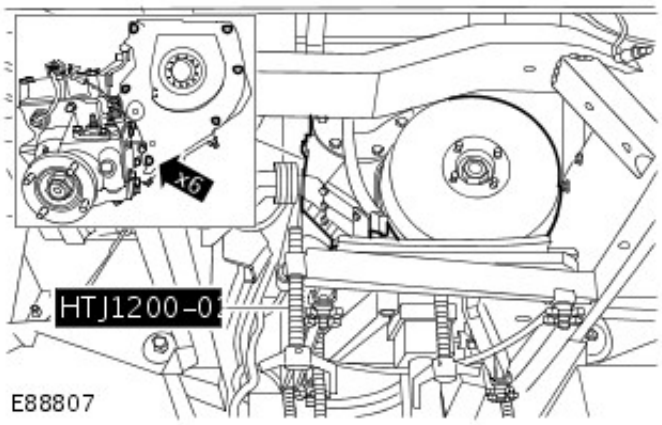
Installation

Special Tool(s)	
	Powertrain Assembly Jack HTJ1200-02
	Transfer Case Support 100-045

Materials

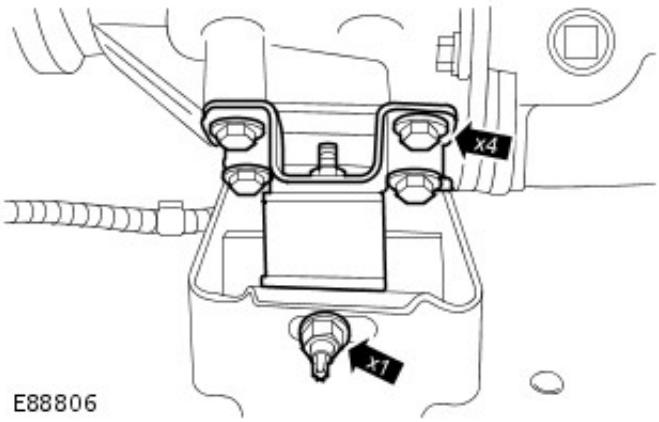
Name	Specification
Silicone Sealant	WSE-M4G323-A4

Installation



1. With assistance, install the transfer case.

- Apply sealant to the bolt threads. sealant
- Tighten the bolts to 45 Nm (33 lb.ft).
- Tighten the nuts to 45 Nm (33 lb.ft).

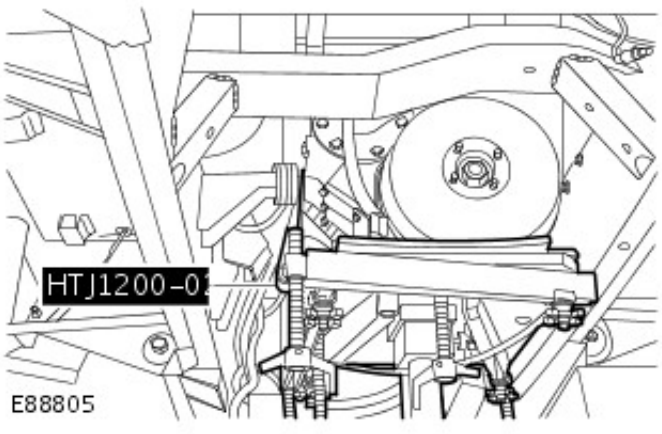


2. NOTE: Lower the transmission jack.

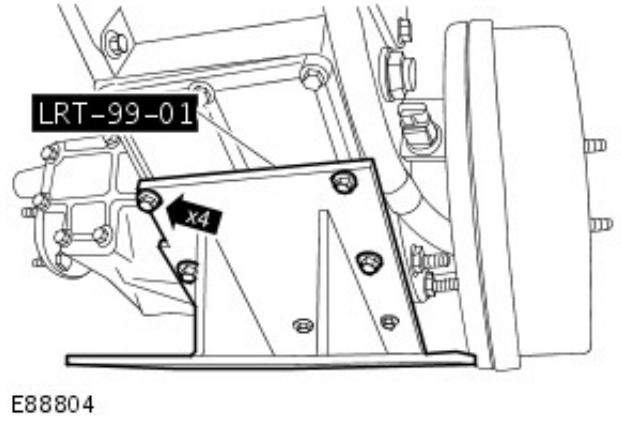
Install the right-hand transfer case mount.

- Tighten the bolts to 85 Nm (63 lb.ft).
- Tighten the nut 48 Nm (35 lb.ft).

3. Remove the special tool.

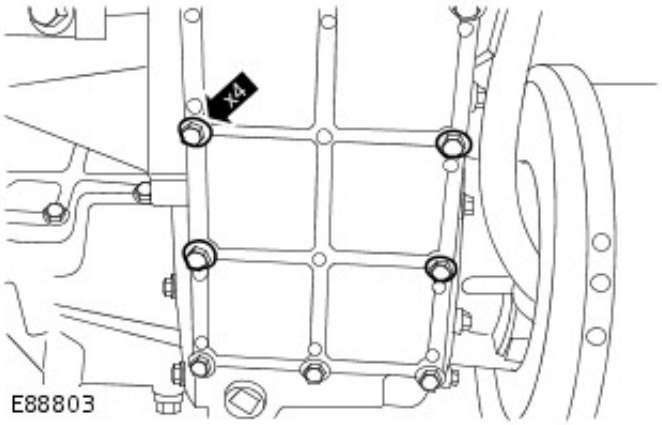


4. Remove the special tool.



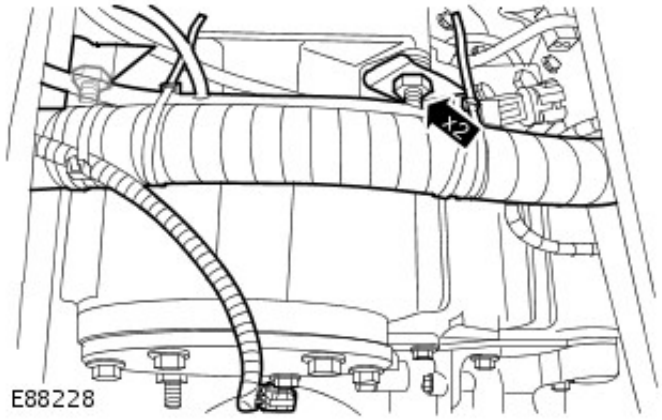
5. Install the bolts.

- Apply sealant to the bolt threads. sealant
- Tighten to 25 Nm (18 lb.ft).

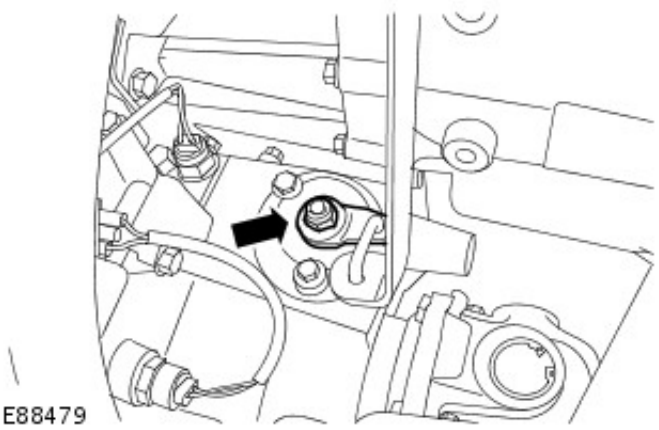


6. Secure the transmission wiring harness.

- Tighten to 45 Nm (33 lb.ft).

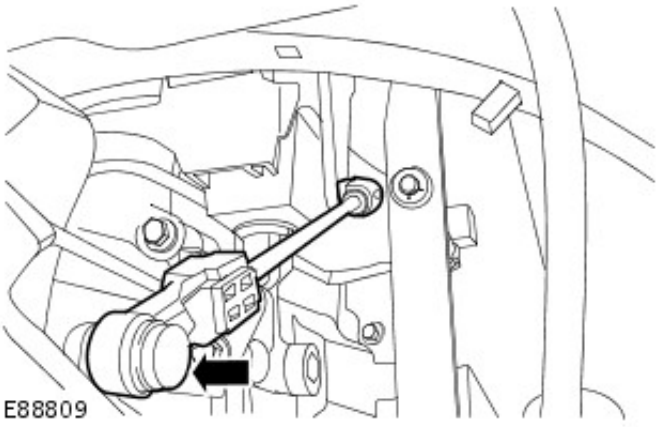


7. Install the differential lock control operating rod.



- Tighten the nut to 25 Nm (18 lb.ft).

8. Install the new retaining clip at the lower end of the pivot arm.



9. NOTE: Make sure the rod is fully engaged on the ball joint.

Connect the high/low range selector rod.

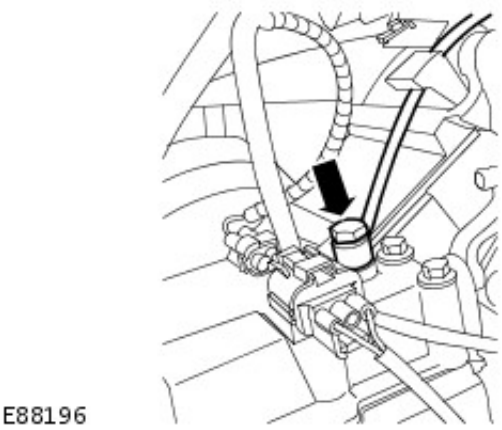
10. Connect the differential lock detection switch electrical connector.

1. Connect the electrical connector.
2. Secure the electrical connector to the bracket.

11. Connect the differential lock warning lamp electrical connector.

1. Connect the electrical connector.
2. Secure the electrical connector to the bracket.

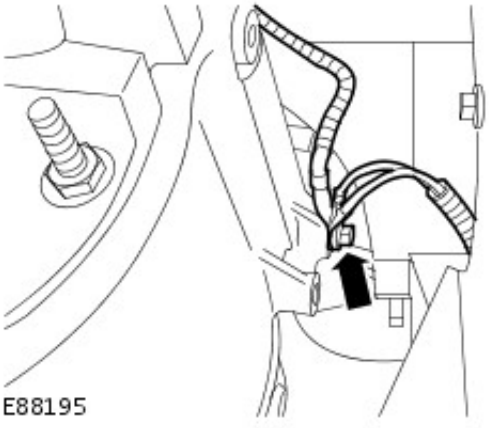
12. NOTE: Remove and discard the blanking caps.


E88196

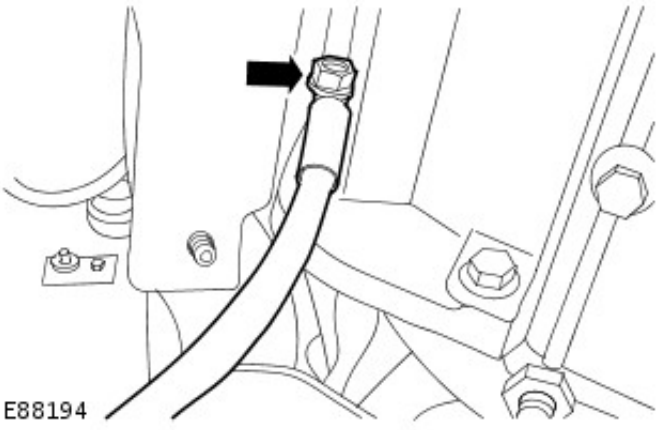
Install the transfer case breather pipe bolt.

- Install new sealing washers.
- Tighten the bolt to 15 Nm (11 lb.ft).

13. Tighten to 12 Nm (9 lb.ft).


E88195

14. Tighten to 45 Nm (33 lb.ft).

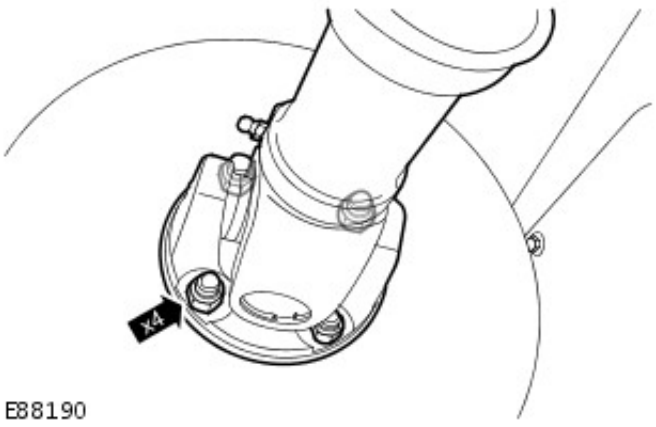

E88194

15. Connect the electronic speedometer electrical connector to the transfer case.

16. NOTE: Remove and discard the tie strap.

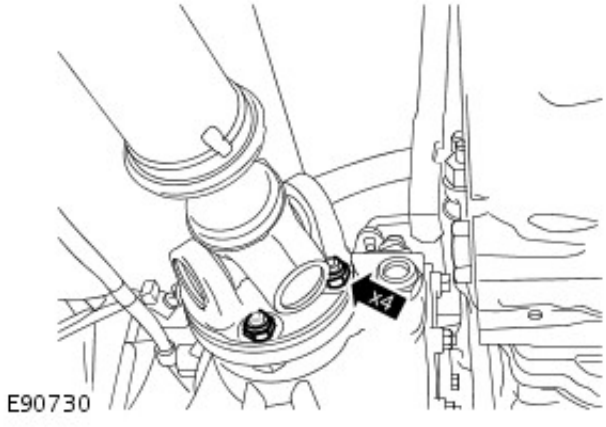
Tighten to 45 Nm (33 lb.ft).

- Align the position of the driveshaft in relation to the drive pinion flange.



E88190

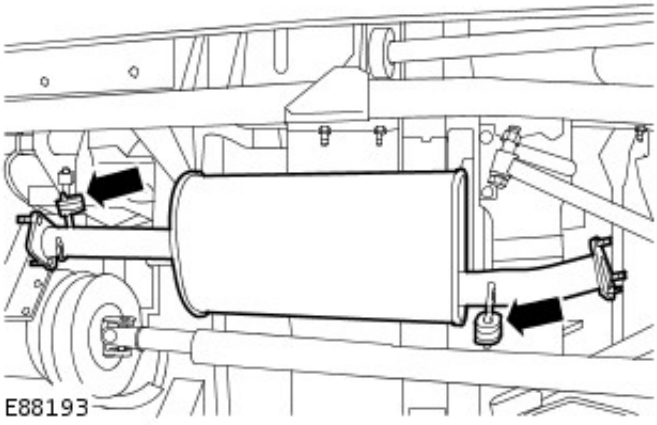
17. NOTE: Install new nuts.



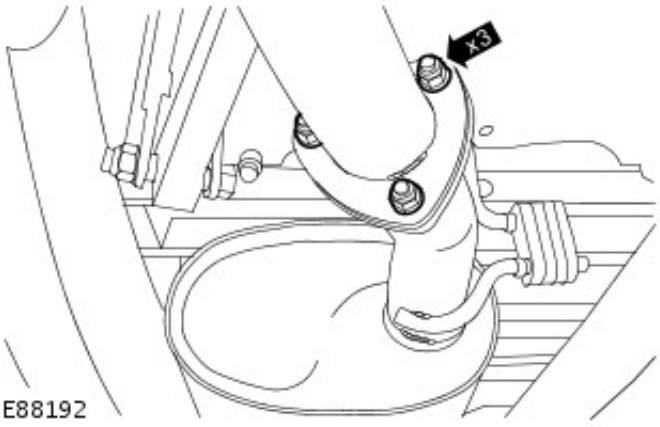
- NOTE: Clean the driveshaft drive flanges and mating faces.

Tighten to 47 Nm (35 lb.ft).

- Align the position of the driveshaft in relation to the drive pinion flange.

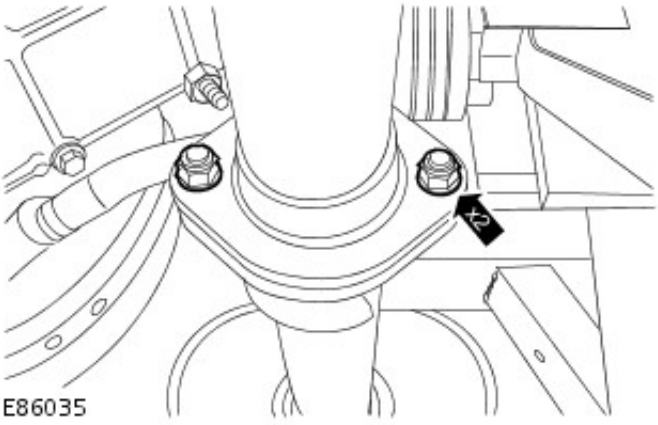


18. Install the intermediate pipe and muffler.



19. Secure the tail pipe to the intermediate pipe.

- Install a new gasket.
- Tighten the new nuts to 30 Nm (22 lb.ft).



20. Secure the intermediate pipe to the catalytic converter.

- Loosely install the new nuts.
  1. Tighten the new nuts to 30 Nm (22 lb.ft).

21. Fill the transfer case.
For additional information, refer to: Transfer Case Draining and Filling (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

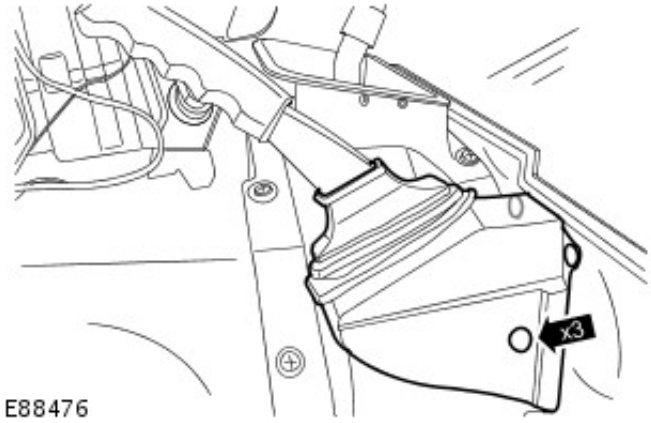
22. Lower the vehicle.

23. Install the parking brake lever clevis pin.

- Install a new pin.

24. Secure the parking brake lever gaiter.

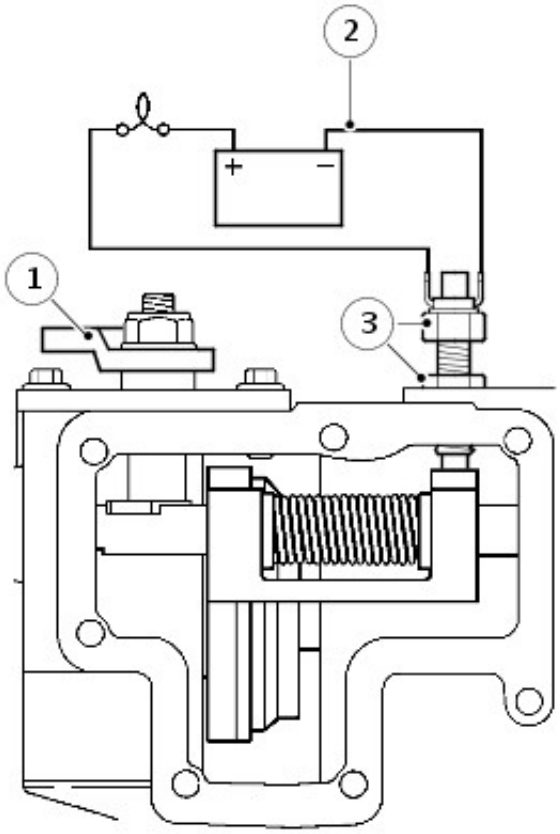
- Install the 3 clips.



Four-Wheel Drive Systems - Differential Lock Indicator Switch Adjustment

General Procedures

- NOTE: This procedure is only necessary for switches fitted with a locknut in place of the threaded spacer.



41M7177

1. Move differential lock selector fork to differential locked position.
2. Connect a 12V test lamp and battery to differential lock indicator switch.
3. Screw switch in until test lamp is illuminated then screw the switch in a further 1/2 turn; tighten locknut.
4. Disengage differential lock, check that test lamp is extinguished.
5. Remove test lamp.

Four-Wheel Drive Systems - Transfer Case Low Range Indicator Switch

Removal and Installation

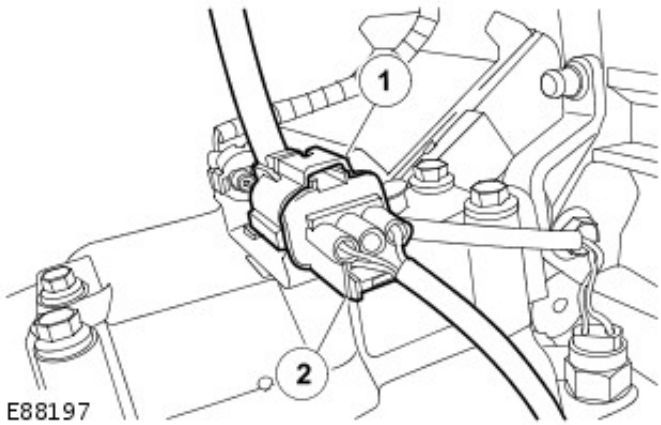
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands. Failure to follow this instruction may result in personal injury.

Raise and support the vehicle.

2. Disconnect the transfer case low range indicator switch electrical connector.

1. Disconnect the electrical connector.
2. Release the electrical connector from the bracket.



3. Remove the transfer case low range indicator switch.

- Remove and discard the sealing washer.

Installation

1. To install, reverse the removal procedure.

- Install a new sealing washer.
- Tighten to 24 Nm (18 lb.ft).

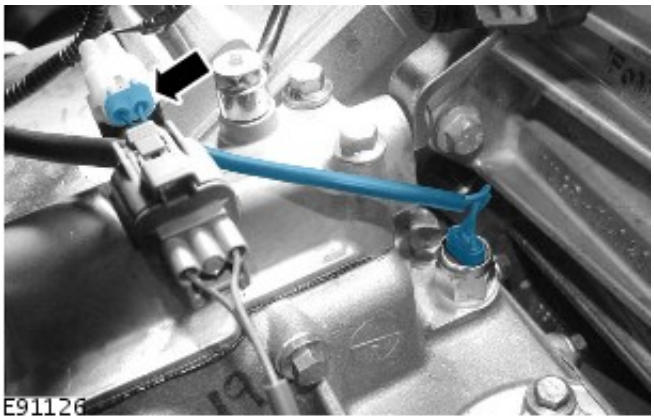
Four-Wheel Drive Systems - Differential Lock Indicator Switch

Removal and Installation

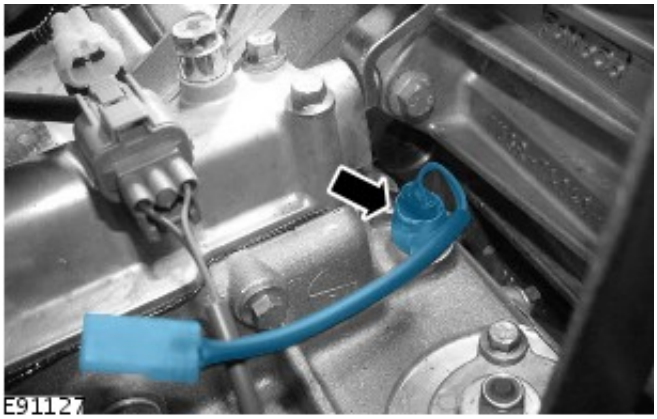
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands. Failure to follow this instruction may result in personal injury.

Raise and support the vehicle.



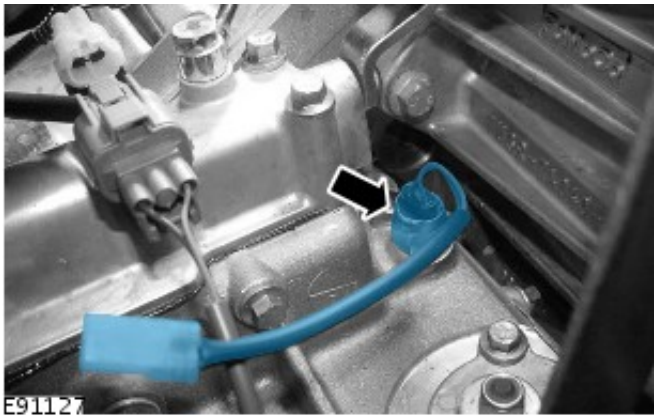
2. Disconnect the differential lock indicator switch electrical connector.



3. Remove the differential lock indicator switch.

- Remove and discard the sealing washer.

Installation



1. To install, reverse the removal procedure.

- Install a new sealing washer.
- Tighten to 24 Nm (18 lb.ft).

Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

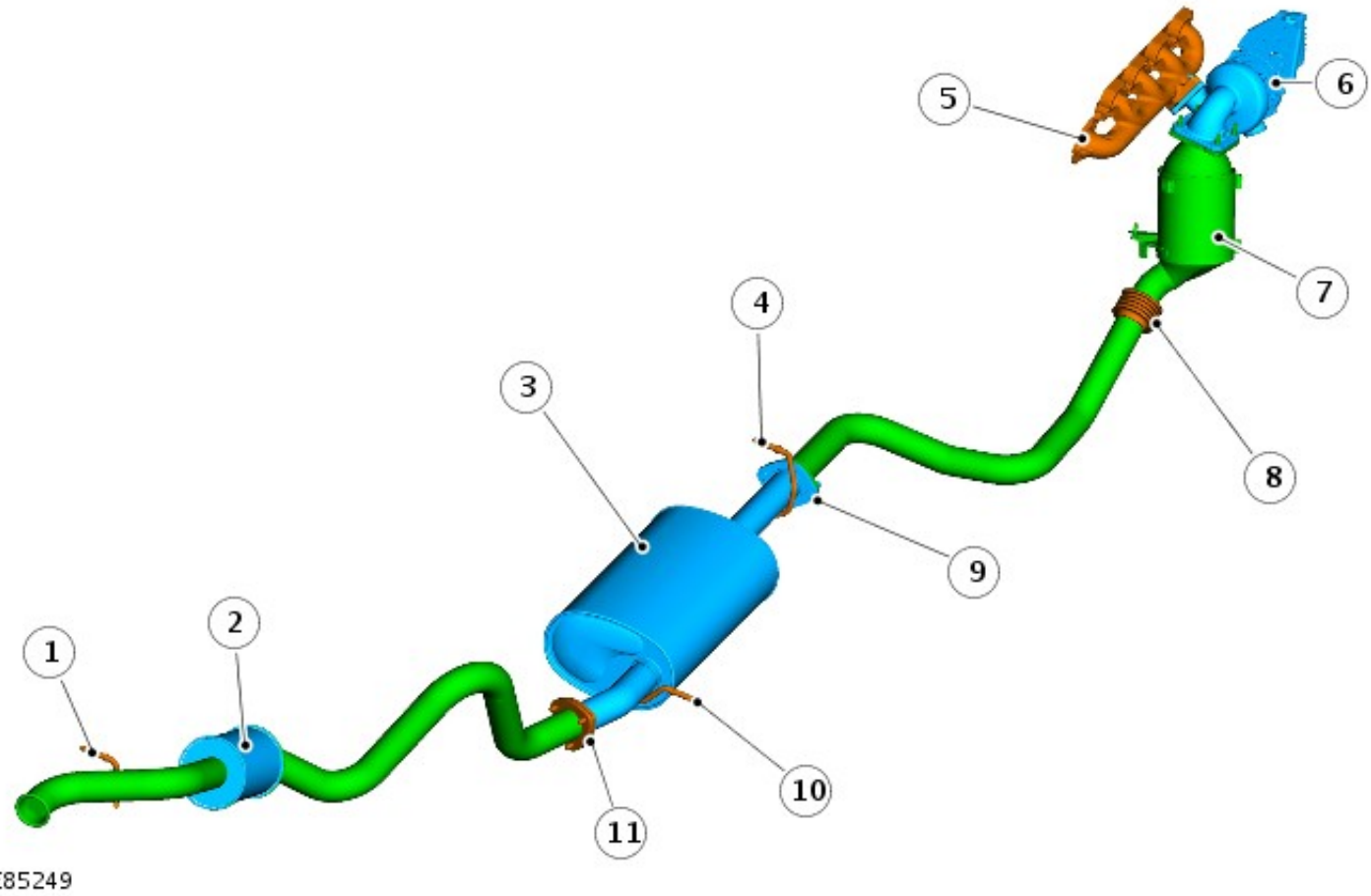
Torque Specifications

Description	Nm	lb-ft
Catalytic converter nuts	45	33
Catalytic converter heatshield	10	7
Turbocharger heatshield	10	7
Catalytic converter lower bracket bolts	30	22
Front muffler to tail pipe nuts	30	22
Front muffler to catalytic converter nuts	30	22
Chassis crossmember nuts and bolts	85	63

Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Exhaust System2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma

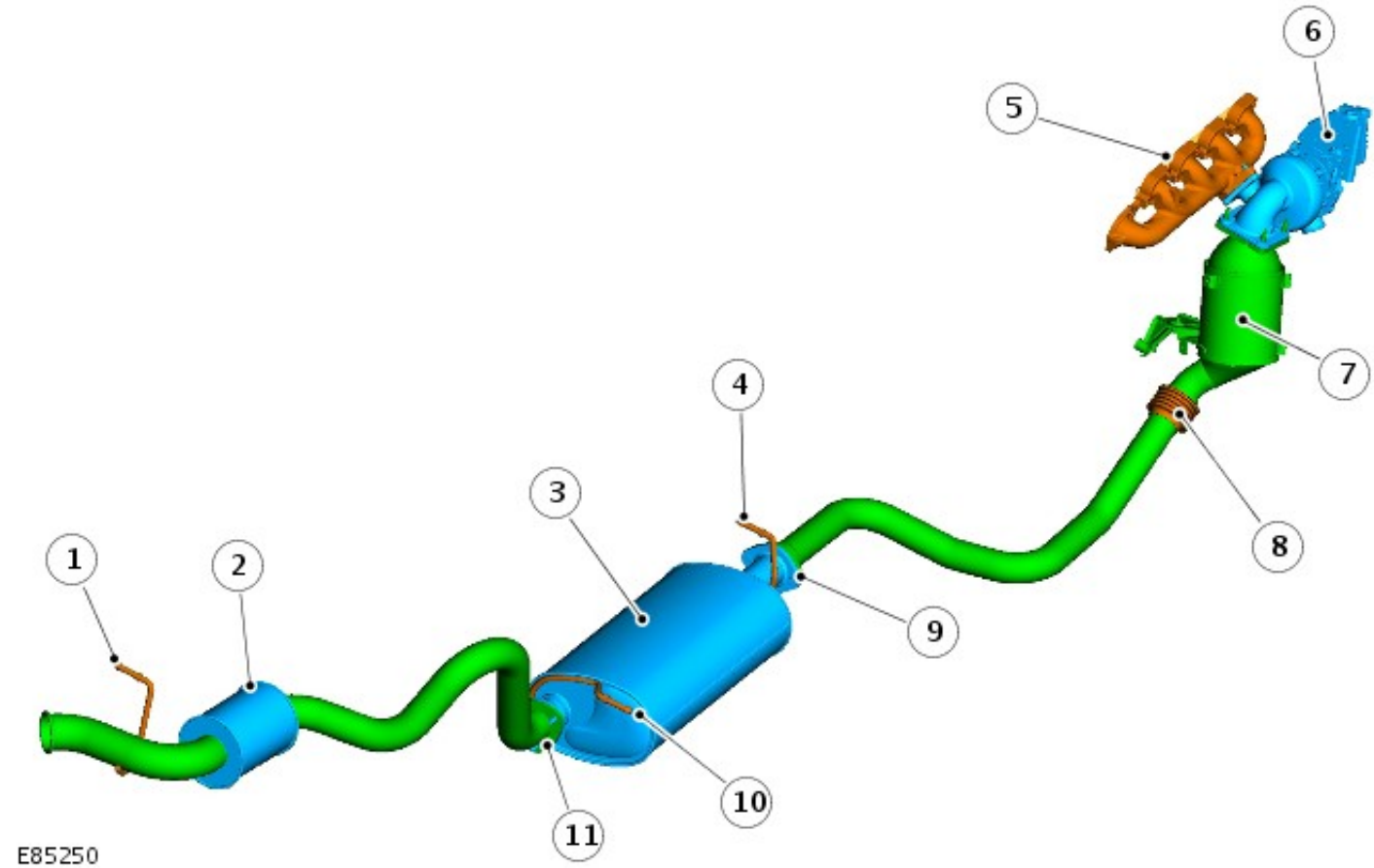
Description and Operation

110 COMPONENT LOCATION



Item	Part Number	Description
1	-	Rear hanger
2	-	Rear muffler
3	-	Canter muffler
4	-	Front center hanger
5	-	Exhaust manifold
6	-	Turbocharger
7	-	Exhaust catalytic convertor
8	-	Flexible joint
9	-	Front joint
10	-	Rear center hanger
11	-	Rear joint

90 COMPONENT LOCATION



Item	Part Number	Description
1	-	Rear hanger
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5	-	Exhaust manifold
6	-	Turbocharger
7	-	Exhaust catalytic convertor
8	-	Flexible joint
9	-	Front joint
10	-	Rear center hanger
11	-	Rear joint

OVERVIEW

The exhaust system is fabricated from stainless steel and is supplied as three separate assemblies;

- A front section incorporating a catalytic converter
- A center section incorporating a center muffler
- A rear section incorporating a rear muffler.

The system is attached to the underside of the body with three mounting rubbers which are located on mild steel hanger bars that are welded to the system. The mounting rubbers locate on corresponding hangers which are welded to the underside of the vehicle body.

The system has service repair items available for the down pipe and crossover pipe. Indentations with arrows show the cut points for the service replacement front section. When a service repair section is used, the pipes at the service joint are connected using an end to end sleeve clamp at the cut points.

FRONT SECTION

The front section has a welded flange with four M10 studs which provide for the attachment to four holes on the turbocharger. There is also a location bracket that connects the rear two studs back to the manifold; these are secured to the Turbocharger using four M10 nuts.

The flange is welded to the catalyst inlet cone which in turn is welded to the catalyst body. An outlet cone is welded to the bottom of the catalyst. This has an outlet elbow pipe welded to it. The outlet elbow and outlet pipe are 60mm (2.36in) O/diameter x 1.5mm (0.06in) thick wall tube. A de-coupler is welded between the outlet elbow and outlet pipe. The catalyst is attached to the engine via a mounting bracket which is bolted to the engine using two M8 bolts.

The rear of the outlet pipe flared end locates into the center section and a loose flange is located onto the two M10 studs. The joint is made with two M10 nuts compressing and securing the joint.

CENTER SECTION

The center muffler is a rolled lock seamed 3 pass absorption construction with a capacity of 21.33 liters (1302in^3). The muffler contains baffles, perforated tubes and E-glass fiber packs which reduce noise as the exhaust gases pass through the muffler. A hanger bar is welded to the front muffler inlet pipe, pointing to the left hand side and provides for the location of a mounting rubber. Another hanger bar is welded to the rear right hand side of the silencer on 90in and outlet pipe on 110in/130in. The inlet and outlet pipes are 63.5mm (2.5in) outside/diameter x 1.5mm (0.06in) thick wall tube.

The center section is secured to the rear section using a flange to flange joint. The rear mounting flange has three studs locating into three holes in the rear section and is secured with 3 x M10 nuts.

REAR SECTION

The 90in rear section uses a straight through lock seamed muffler volume 0.73 liters (44.55in^3). The inlet pipe is 63.5mm (2.5in) outside diameter x 1.5mm (0.06in) thick wall tube, with a flange to connect to the center section. The outlet pipe is 70mm (2.76in) outside diameter x 1.2mm (0.047in) thick wall tube with a rolled end safety feature. The outlet pipe has a mounting bar welded to the left hand side which locates in a mounting rubber.

The 110/130in rear section uses a straight through lock seamed muffler volume 0.73 liters (44.55in^3). The inlet pipe is 63.5mm (2.5in) outside diameter x 1.5mm (0.06in) thick wall tube, with a flange to connect to the center section. The outlet pipe is 63.5mm (2.5in) outside diameter x 1.2mm (0.047in) thick wall tube with a rolled end safety feature. The outlet pipe has a mounting bar welded to the left hand side which locates to a mounting rubber.

Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Catalytic Converter

Removal and Installation

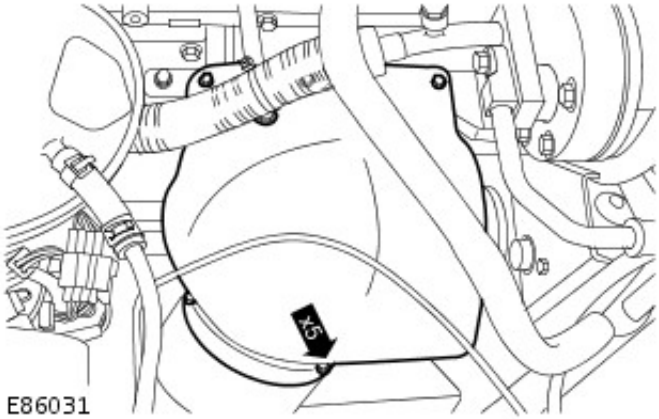
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.
For additional information, refer to: Lifting (100-02 Jacking and Lifting, Description and Operation).

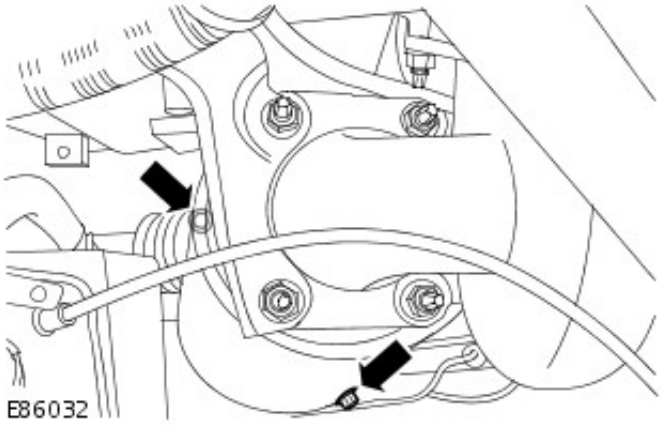
2. Remove the turbocharger heat shield.

- Remove the 5 bolts.

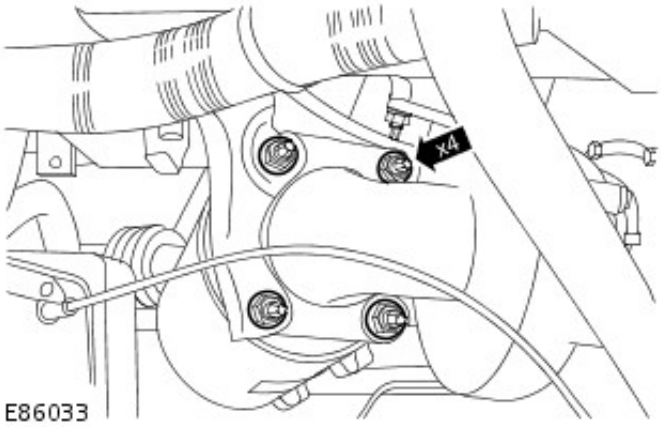


3. Remove the catalytic converter heat shield.

- Remove the 2 bolts.

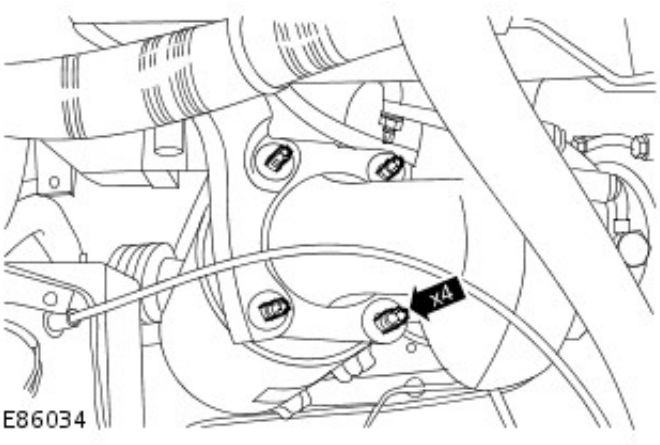


4. Remove and discard the 4 nuts from the catalytic converter.



5. Remove and discard the 4 studs from the catalytic

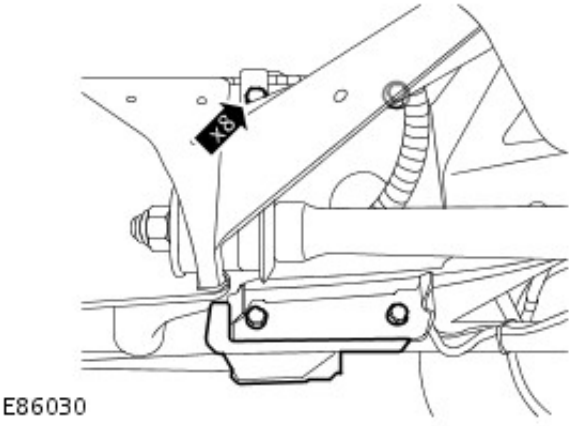
converter.



6. NOTE: Left-hand side shown, right-hand side similar.

Remove the chassis cross member.

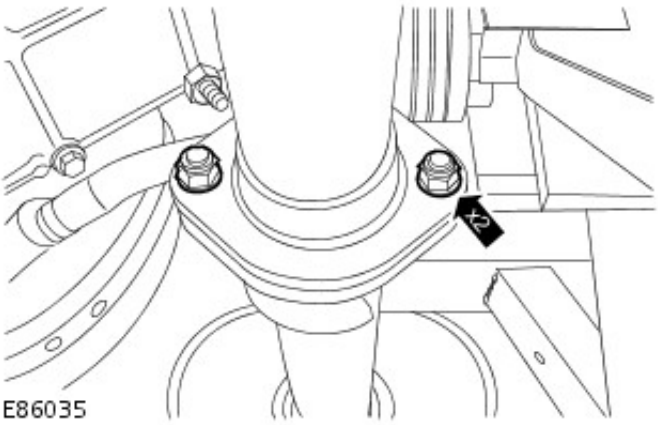
- Remove the 8 bolts.



7. Remove the front driveshaft.
For additional information, refer to: Front Driveshaft (205-01 Driveshaft, Removal and Installation).

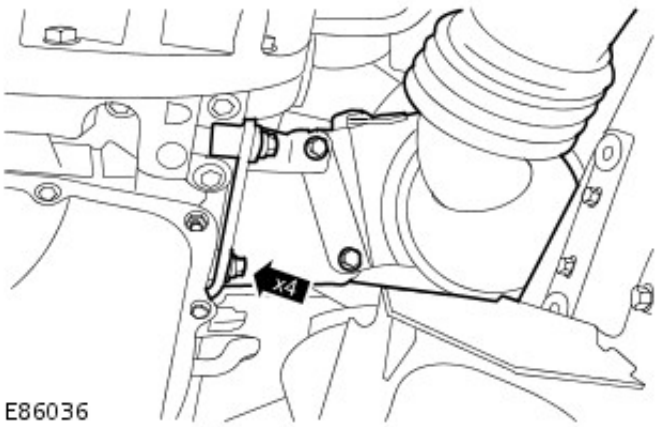
8. Release the catalytic converter.

- Remove and discard the 2 nuts.



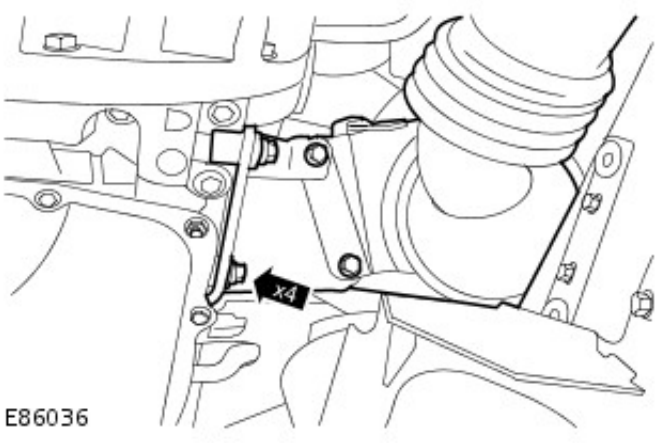
9. Remove the catalytic converter.

- Remove the 4 bolts.

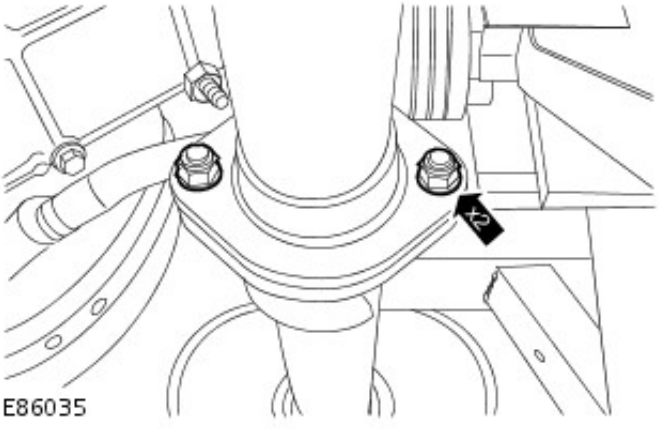


Installation

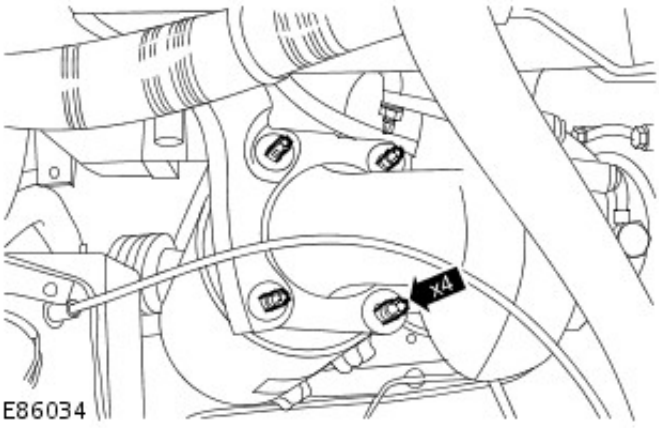
1. Install the catalytic converter.



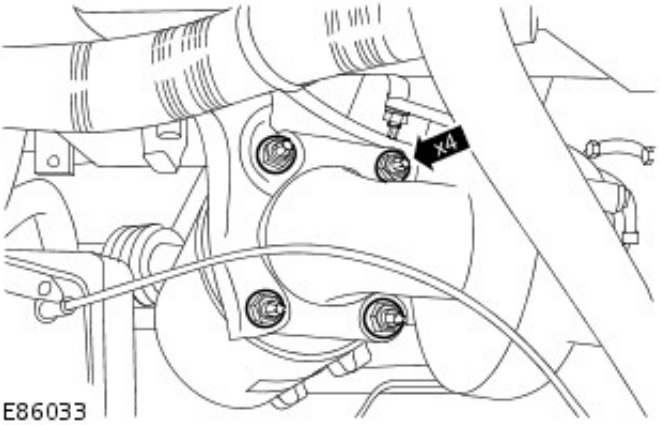
1. Install the catalytic converter.
   - Loosely install the bolts.



2. Secure the catalytic converter.
   - Loosely install the new nuts.

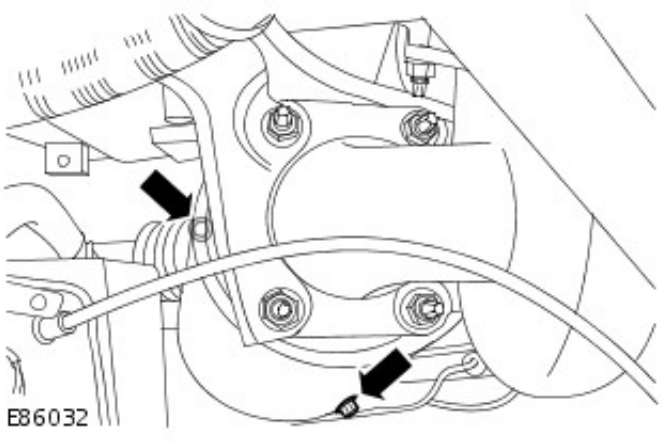


3. Install 4 new studs to the catalytic converter.

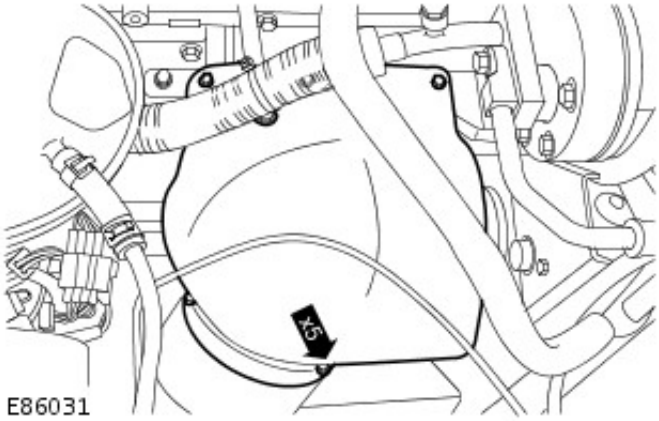


4. Install 4 new nuts to the catalytic converter.
   - Tighten to 45 Nm (33 lb.ft).

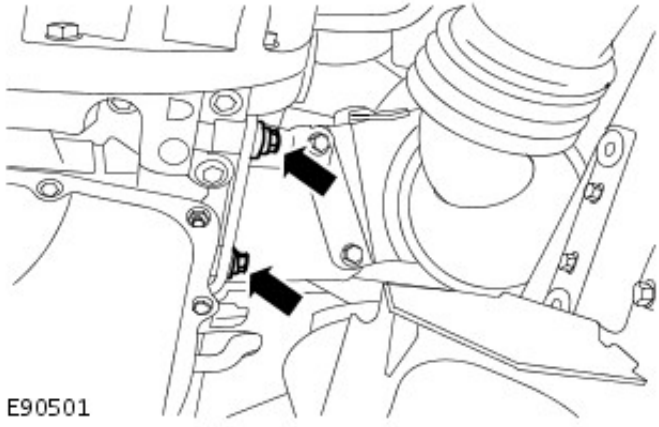
5. Install the catalytic converter heat shield.



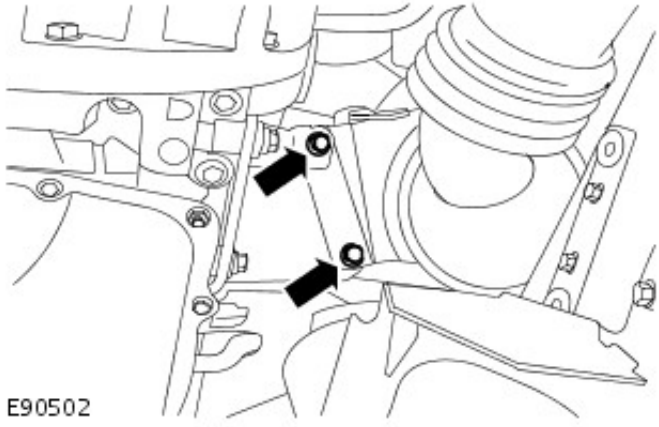
5. Install the catalytic converter heat shield.
   - Tighten to 10 Nm (7 lb.ft).



6. Install the turbocharger heat shield.
   - Tighten to 10 Nm (7 lb.ft).

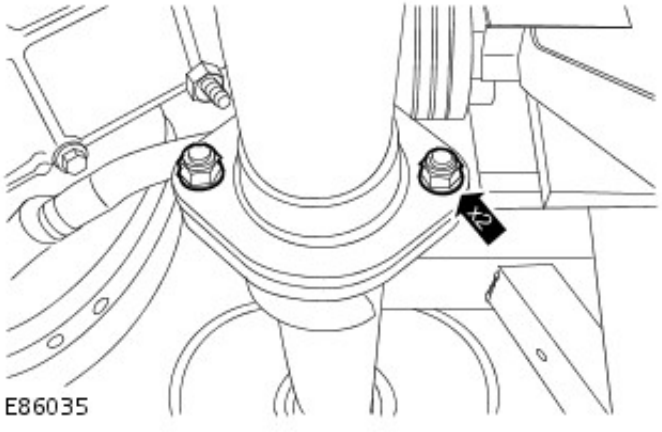


7. Tighten to 30 Nm (22 lb.ft).



8. Tighten to 30 Nm (22 lb.ft).

9. Tighten to 30 Nm (22 lb.ft).

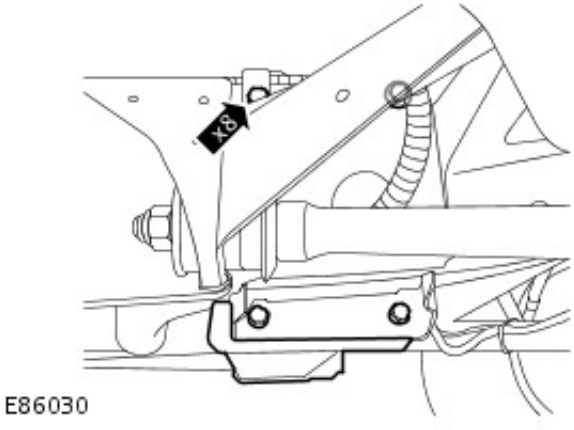


10. Install the front driveshaft.
For additional information, refer to: Front Driveshaft (205-01 Driveshaft, Removal and Installation).

11. NOTE: Left-hand side shown, right-hand side similar.

Install the chassis cross member.

- Tighten to 85 Nm (63 lb.ft).



Exhaust System - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Front Muffler

Removal and Installation

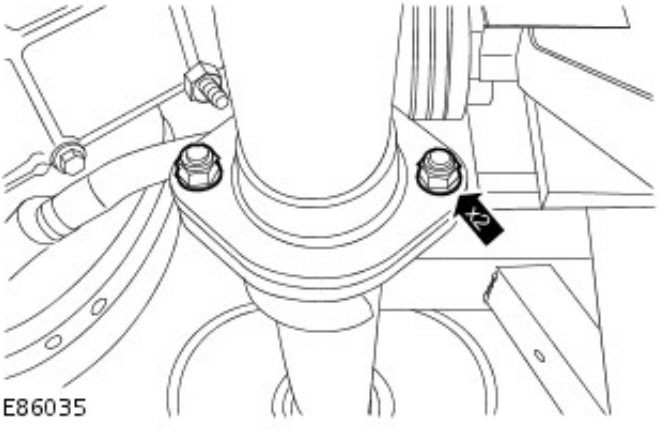
Removal

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

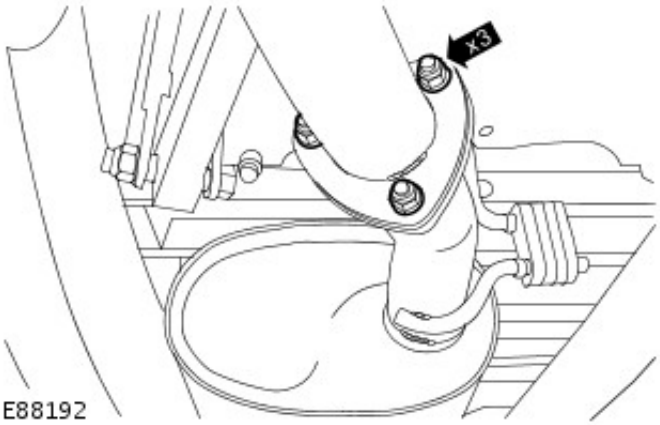
2. Release the front muffler from the catalytic converter.

- Remove and discard the 2 nuts.

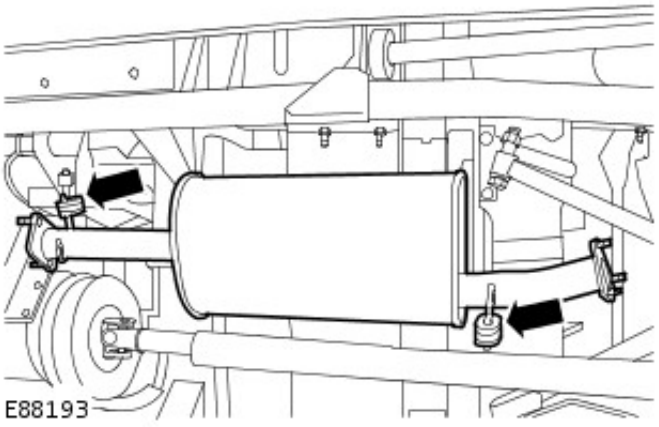


3. Release the front muffler from the tail pipe.

- Remove and discard the 3 nuts.
- Remove and discard the gasket.

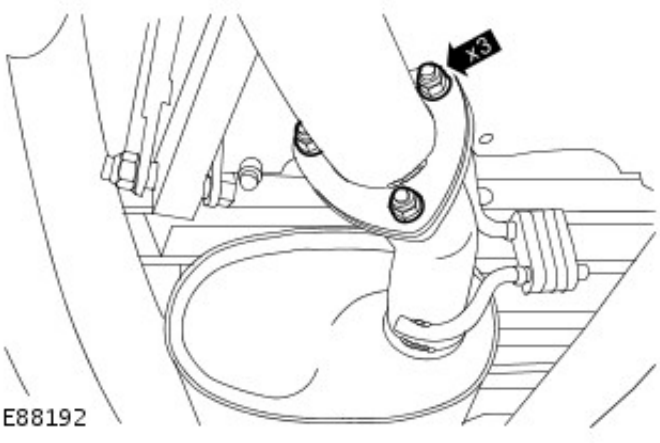


4. Remove the intermediate pipe and muffler.



Installation

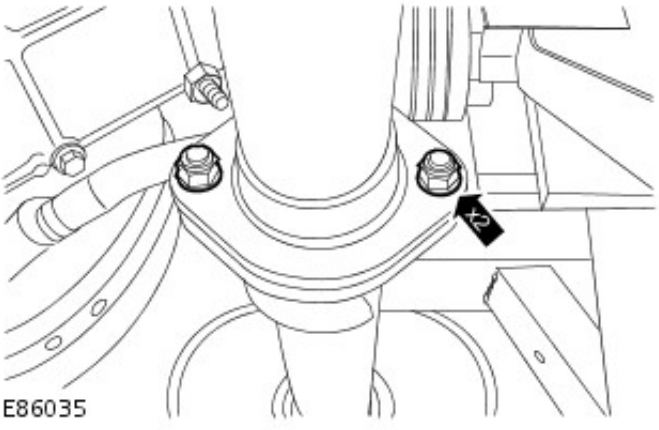
1. NOTE: Install a new gasket.



- NOTE: Install new nuts.

To install, reverse the removal procedure.

- Tighten to 30 Nm (22 lb.ft).



2. NOTE: Install new nuts.

Tighten to 30 Nm (22 lb.ft).

Fuel System - General Information - Diesel Filter Water Drain-Off

General Procedures

• WARNINGS:

The spilling of fuel is unavoidable during this operation. Ensure that all necessary precautions are taken to prevent fire and explosion.

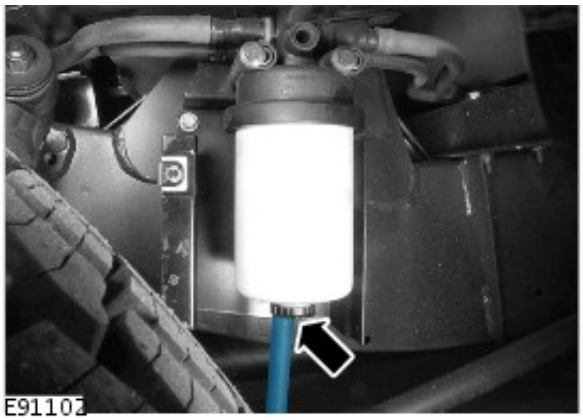
Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

CAUTION: Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.



1. Drain the fuel filter element.

- Attach a suitable drain tube to the fuel filter water drain off port.
- Loosen the water drain off port one complete turn and allow the fuel to drain into a container.
- Tighten the water drain off port.
- Remove the drain tube.
- Remove the container.

2. Bleed the fuel system.
For additional information, refer to: Low-Pressure Fuel System Bleeding (310-00 Fuel System - General Information, General Procedures).

Fuel System - General Information - Fuel Tank Draining

General Procedures

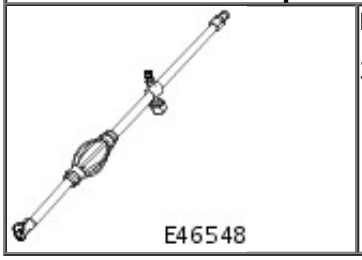
1. Remove battery cover.
2. Disconnect both leads from battery, earth lead first.

WARNING: Fuel vapour is highly flammable and in contained spaces is also explosive and toxic. Always have a fire extinguisher containing FOAM, CO2, GAS OR POWDER close at hand when handling or draining fuel.

3. Using a fuel recovery appliance, drain the fuel from the tank into a sealed container. Follow the manufacturers instructions for the connection and safe use of the appliance.
4. Remove filler cap and insert hose into filler neck.
5. Connect bowser earth line. Drain fuel.
6. Connect battery leads.
7. Fit battery cover.

Fuel System - General Information - Low-Pressure Fuel System Bleeding

General Procedures

Special Tool(s)	
 E46548	Hand pressure pump 310-110

• WARNINGS:

After carrying out repairs, the fuel system must be checked visually for leaks. Failure to follow this instruction may result in personal injury.

Do not carry or operate cellular phones when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

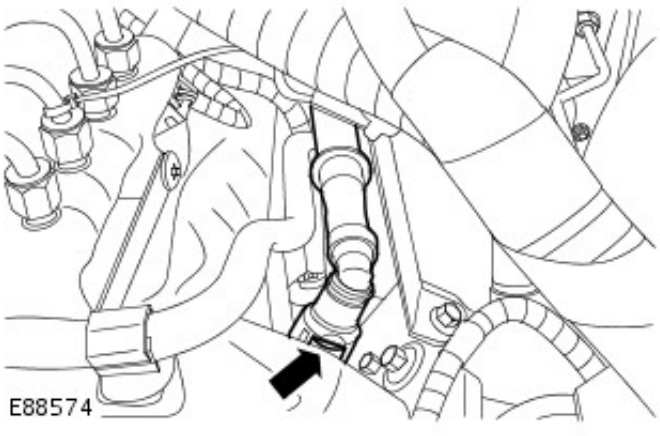
This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling precautions. Failure to follow these instructions may result in personal injury.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

• CAUTIONS:

Diesel fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or lines. Failure to follow this instruction may result in foreign matter ingress to the fuel injection system.

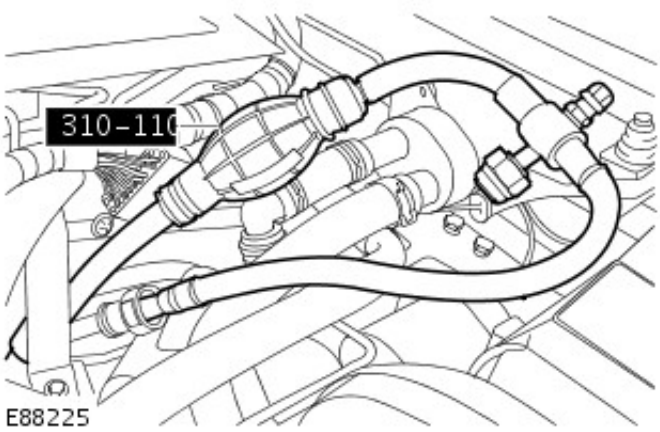
Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.


E88574

1. Disconnect the fuel injection pump supply line.
For additional information, refer to: Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).

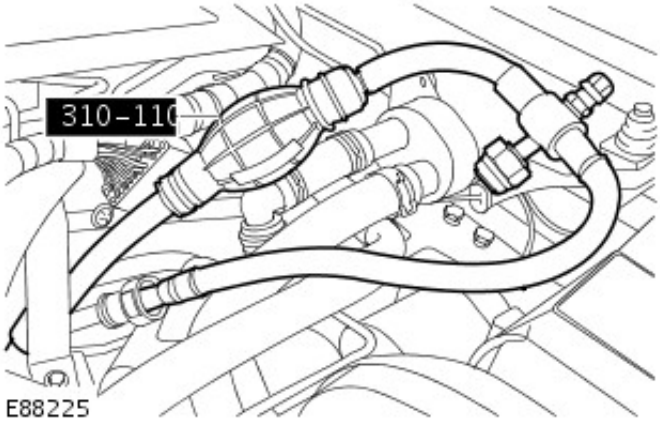
- Position an absorbent cloth to collect any fluid spillage.

2. Install the special tool.



- Operate the hand pressure pump special tool until fuel starts to flow through the clear plastic pipe and the special tool becomes firm.

3. Remove the special tool.



4. Connect the fuel injection pump supply line.
For additional information, refer to: Quick Release Coupling (310-00 Fuel System - General Information, General Procedures).

- Remove the absorbent cloth.

Fuel System - General Information - Quick Release Coupling

General Procedures

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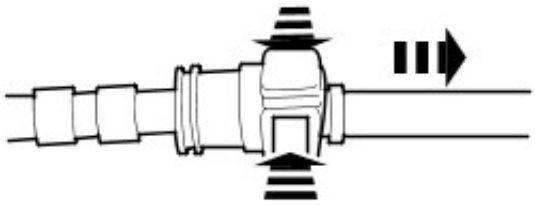
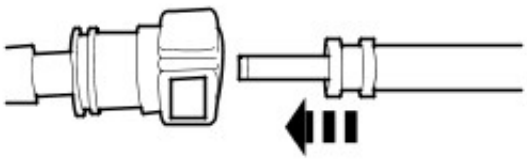


VUE0032292

1. Disconnect the fuel line quick release coupling.

- Push the fuel line quick release buttons and pull the 2 halves of the fuel line to disconnect.



VUE0032293

2. CAUTION: Make sure the fuel line quick release coupling clicks into place when connecting the fuel line. To make sure that the quick release coupling is fully seated pull on the 2 halves of the fuel line.

Connect the fuel line quick release coupling.

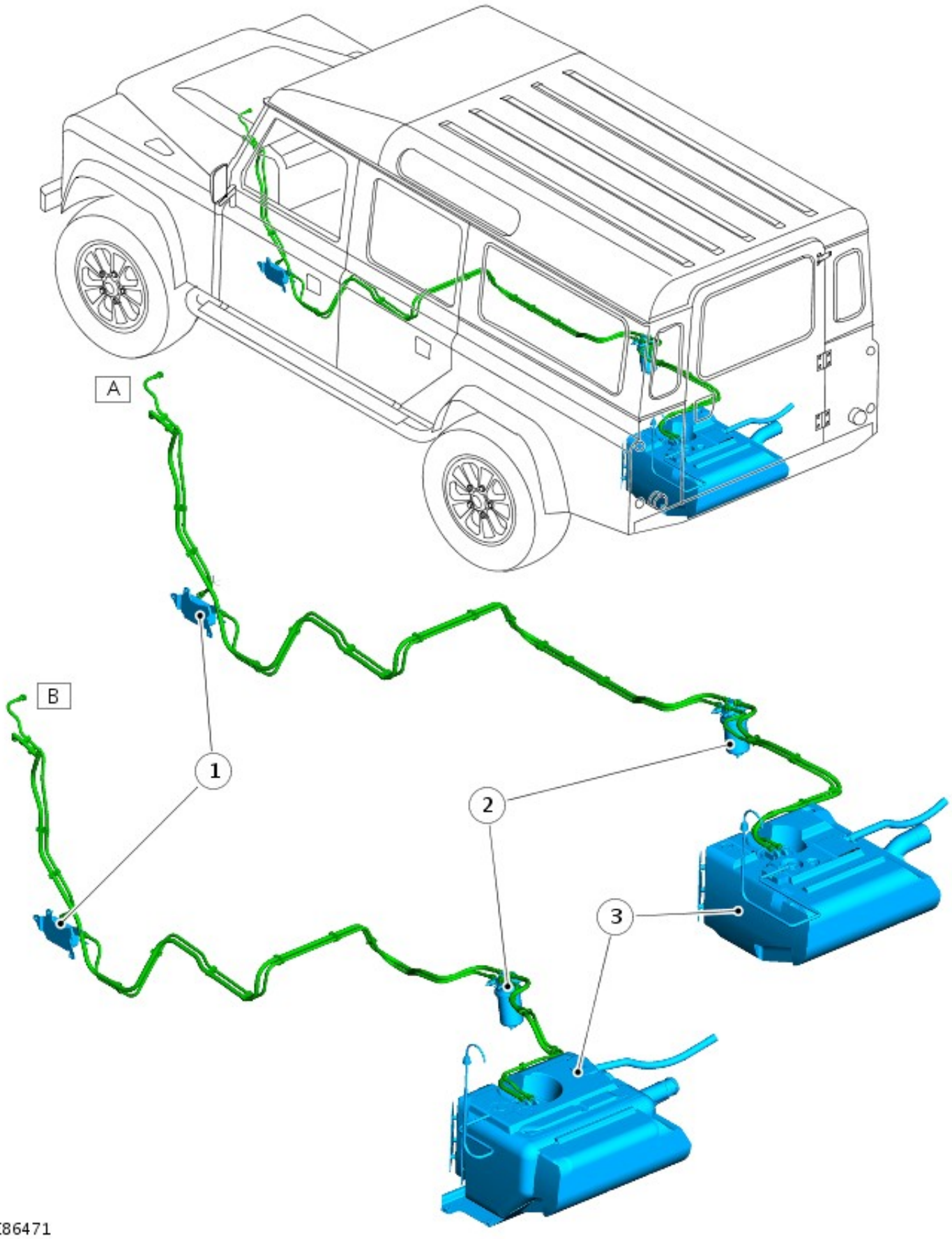
Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Fuel level sender locking ring	35	26
Fuel tank support bracket bolts	45	33
Fuel tank support bracket nuts	25	18

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Tank and Lines2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma

Description and Operation

COMPONENT LOCATION



Item	Part Number	Description

A	-	110 Variant
B	-	90 Variant
1	-	Fuel cooler
2	-	Fuel filter
3	-	Fuel tank

OVERVIEW

The fuel delivery system comprises fuel filler pipe and hose, fuel tank, (including sender assembly and breather system), fuel filter, fuel cooler, priming valve and connecting fuel lines.

The fuel system supplies fuel to the engine via a lift pump which is integral to the engine mounted injector pump. The fuel system is a depression system with the inlet pressure at the transfer pump being -30 to -20 kPa.

Return flow from the engine is returned to the filter. To prevent filter waxing at low temperatures a thermostatic diverter routes the warmed return flow back through the filter to the engine. At higher temperatures the return flow is diverted back to the tank.

FUEL FILLER AND CAP

The fuel filler is located in the right hand rear quarter panel, behind an access flap. The flap is opened electrically using a switch on the fascia which operates a release solenoid.

The filler is closed by a threaded plastic cap which screws into the filler neck. The cap has a ratchet mechanism to prevent over tightening and seals against the filler neck to prevent the escape of fuel vapor. The filler cap has a valve which relieves fuel pressure to atmosphere at approximately 0.12 to 0.13 bar (1.8 to 2.0 lbf.in²) and opens in the opposite direction at approximately 0.04 bar (0.7 lbf.in²) vacuum.

A High Density Polyethylene (HDPE) molded filler tube connects the filler to the tank via a flexible hose.

FUEL TANK

The fuel tank is located at the rear underside of the vehicle between the chassis longitudinals.

The cradle is attached to the chassis with six screws. When the cradle is attached to the chassis, the tank is positively secured via foam pads which bear against the central chassis cross beam. A protective cover is fitted to the front right hand corner of the tank and provides additional protection.

The fuel tank is manufactured from HDPE. The tank is a sealed unit with the only internal access being via the pump module flange aperture on the top of the tank.

A reflective metallic covering is attached to the tank with two scrivets to shield the tank from heat generated by the exhaust system.

Fuel Tank Capacities

Variant	Fuel Tank Capacity
90	56 liters (13.2 gallons)
110	70 liters (16.2 gallons)

FUEL TANK BREATHER SYSTEM

The filler tube incorporates a tank vent which allows air and fuel vapor displaced from the tank when filling to vent to atmosphere via the filler neck.

A breather spout within the tank controls the tank 'full' height. When fuel covers the spout it prevents fuel vapor and air from escaping from the tank. This causes the fuel to 'back-up' in the filler tube and shuts off the filler gun. The position of the spout ensures that when the filler gun shuts off, a vapor space of approximately 10% of the tanks total capacity remains. The vapor space ensures that the Roll over Valve (ROV) is always above the fuel level and vapor can escape and allow the tank to breathe.

The ROV is welded on the top surface of the tank. The ROV is connected to the atmospheric vent pipe. The ROV allows fuel vapor to pass through it during normal vehicle operation. In the event of the vehicle being overturned the valve shuts off, sealing the tank and preventing fuel from spilling from the atmospheric vent pipe.

The atmospheric vent pipe includes a two-way valve which allows for over-pressure relief one way and allows for air to enter the tank as the system operates in depression.

FUEL LEVEL SENSOR

The fuel gauge sender unit is located inside the tank. The sender module is accessed and assembled by an aperture in the top of the tank. The module flange is locked in place and sealed by a steel locking ring.

The fuel sender assembly comprises a top cover flange which locates the electrical connector for the sender and two steel fuel pipe couplings.

The flange is sealed by a rubber seal positioned between the flange and the locking ring housing.

The top cover is attached to the swirl pot assembly by two spring loaded steel pillars. The springs ensure the swirl pot locates positively on the bottom of the tank.

The swirl pot is capped by a housing which locates the fuel gauge sender unit.

The function of the swirl pot is to act as a fuel reserve ensuring the fuel pick-up is always covered by fuel. This is achieved by the return flow being directed into the swirl pot and a jet pump provides additional flow into the pot from the fuel remaining in the tank, the jet pump is powered by the return flow. In addition a non-return valve is located in the base of the swirl pot assembly. When the fuel tank is full, fuel pressure keeps the valve lifted from its seat allowing fuel to flow into the swirl pot. As the tank level reduces, the fuel pressure in the tank reduces causing the valve to close. When the valve is closed fuel is retained in the swirl pot.

Flexible pipes connected to the top cover provide the feed and return from the swirl pot.

The fuel gauge sender unit comprises a potentiometer operated by a float. .The float rises and falls with the fuel level in the tank and moves the potentiometer accordingly.

A voltage is supplied to the potentiometer from the instrument pack. The output resistance from the potentiometer varies according to the fuel level. The resistance is displayed by the fuel gauge in the instrument pack.

A warning lamp is incorporated in the instrument cluster and illuminates when the fuel level is at or below 10 liters (2.64 US gallons).

ROLL OVER VALVES (ROVs)

Two ROVs are located on the carrier and are connected via pipes to a liquid vapor separator. The separator, which is also attached to the carrier, is connected via a pipe to the tank breather outlet in the pump module flange. The ROVs contain non-return valves which close in the event of the vehicle overturning, preventing liquid fuel escaping from the tank via the breather pipe.

FUEL FILTER

E86472

The fuel filter removes particulate matter from the fuel and also separates water which accumulates at the bottom of the filter.

The fuel filter is positioned on the chassis to the right of the fuel tank. The fuel feed and return to and from the engine passes through the filter. Connections are made using quick fit connectors.

A steel rear cover is attached to the chassis longitudinal by four M8 screws.

The filter is screwed to the back plate by two M8 bolts.

A steel protection cover is fixed onto the back cover using a ¼ turn fastener.

The filter has an internal air bleed feature which allows air into the fuel supply to the engine in small, manageable amounts.

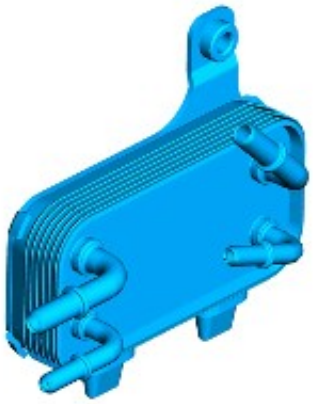
The thermostatic diverter valve is fully closed at 45 degrees Celsius and sends fuel directly to the tank. When the diverter is open fuel is re-circulated through the filter to the engine.

The fuel filter has a replaceable twist-on canister filter element which is sealed to the filter body with rubber seals. The lower part of the canister has a screw-in cap for water draining.

The service interval for the canister change is 24,000 miles.

For markets with poor quality fuel the service interval may need to be reduced.

FUEL COOLER



E86473

The fuel cooler uses engine coolant, from the radiator, to cool fuel returning to the tank from the HP injection pump.

The cooler is fixed to a bracket which is attached to the inner left hand chassis rail. The bracket has two slots which accept two plastic location pegs which are attached to the cooler. An M8 bolt secures the cooler to the bracket.

The cooler has four quick fit connections. Fuel inlet and outlet and coolant inlet feed and return.

BLEED VALVE

The bleed valve is located in the fuel feed line near to the injector pump. It facilitates the use of a vacuum connection to prime the fuel system and remove air during initial and service primes. This protects the injector pump from air locking.

FUEL LINES

Three fuel line assemblies connect the feed and return flow from tank to the filter, filter to the cooler and cooler to the engine.

The fuel lines are constructed from conductive 1 mm thick nylon with 2 mm thick santoprene fire resistant, anti-abrasive coating throughout. The fuel feed line has a larger diameter than the return.

LOW FUEL INDICATION AND RUN DRY STRATEGY

The run-dry strategy is used to maintain the systems fuel prime at fuel run out. It ensures the minimum amount of fuel is always left in the swirl pot.

The instrument cluster activates the yellow low fuel warning light, (next to the fuel gauge) with 15% of fuel remaining in the tank. The fuel gauge will indicate empty with 11% of fuel left in the tank.

With 4 liters left in the tank the run-dry strategy will be invoked. An engine mis-fire will be induced for approximately 1 mile after which the engine will be shut down. The engine can be re-started in mis-fire mode and will continue to run for a further mile until the engine shuts down again. This can be repeated until the fuel suction port in the tank is uncovered and causes engine fuel starvation and loss of prime. Re-starts after run-dry shut down are not recommended.

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Cooler

Removal and Installation

Removal

• WARNINGS:

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Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable vapors are always present and may ignite. Failure to follow these instructions may result in personal injury.

If fuel contacts the eyes, flush the eyes with cold water or eyewash solution and seek immediate medical attention.

This procedure involves fuel handling. Be prepared for fuel spillage at all times and always observe fuel handling precautions. Failure to follow these instructions may result in personal injury.

Wash hands thoroughly after fuel handling, as prolonged contact may cause irritation. Should irritation develop, seek medical attention.

• CAUTIONS:

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Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

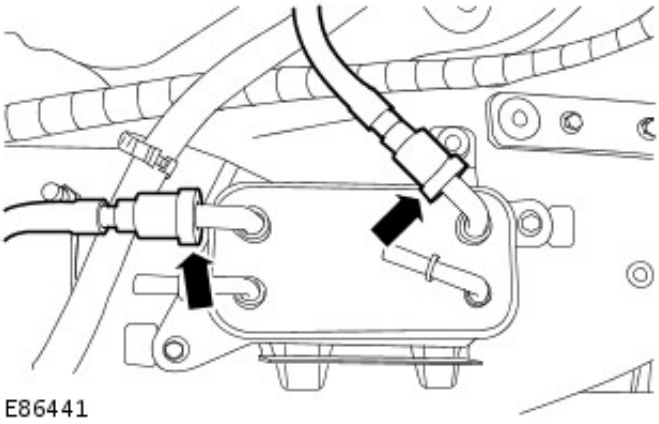
2. Drain the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

3. CAUTIONS:

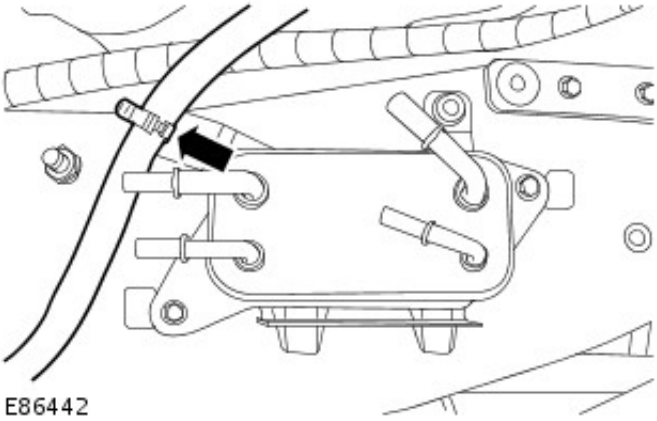
Make sure that all openings are sealed. Use new blanking caps.

Fluid loss is unavoidable, use a suitable container to collect any fluid loss.

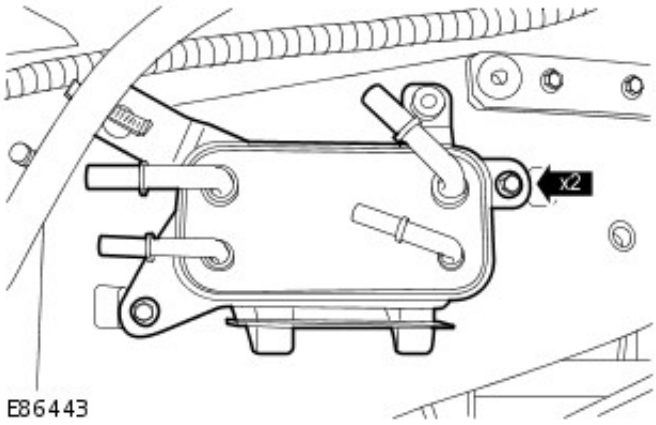
Disconnect the 2 fuel lines.


E86441

4. Release the fuel return line from the clip.



4. Release the fuel return line from the clip.



5. Remove the fuel cooler.

- Remove the 2 bolts.

Installation

1. Install the fuel cooler.

- Tighten the bolts to 23 Nm (17 lb.ft).

2. Secure the fuel return line in the clip.

3. NOTE: Remove and discard the blanking caps.

Connect the fuel lines.

4. Bleed the fuel system.
For additional information, refer to: Low-Pressure Fuel System Bleeding (310-00 Fuel System - General Information, General Procedures).

5. Fill and bleed the cooling system.
For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Filter

Removal and Installation

Removal

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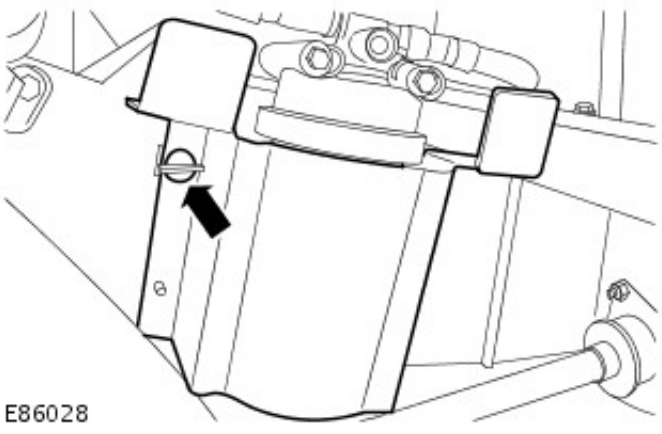
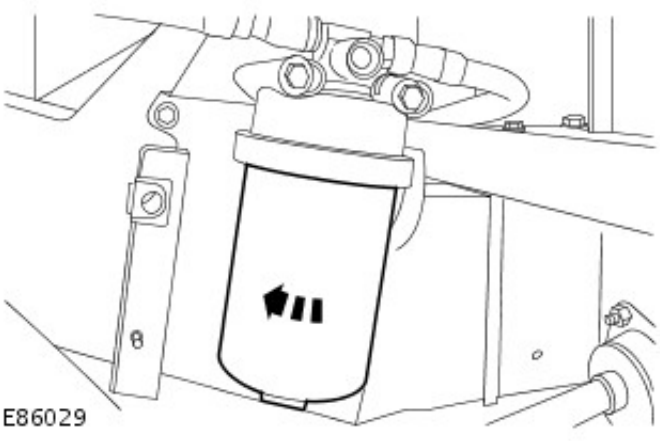


1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Remove the fuel filter cover.

- Loosen the clip.



3. CAUTION: Make sure that the area around the component is clean and free of foreign material.

Remove the fuel filter.

- Position a container to collect the fluid spillage.

Installation

1. CAUTION: Clean the component mating faces.

Install the fuel filter.

- Remove the container.

2. Install the fuel filter cover.

- Tighten the clip.

3. Bleed the fuel system.
For additional information, refer to: Low-Pressure Fuel System Bleeding (310-00 Fuel System - General Information, General Procedures).

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Level Sender

Removal and Installation

Special Tool(s)	
	Wrench, Fuel tank 310-118

Removal

• WARNINGS:

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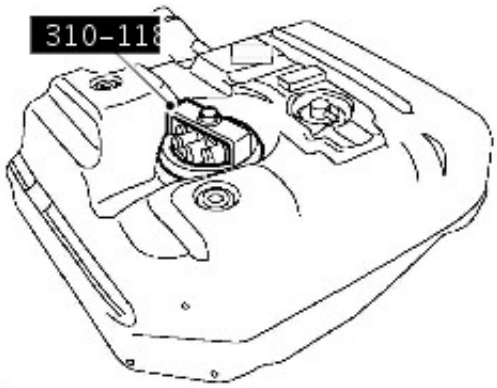
1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

3. Remove the fuel tank.
For additional information, refer to: Fuel Tank (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

4. Remove the fuel level sender.



E89875

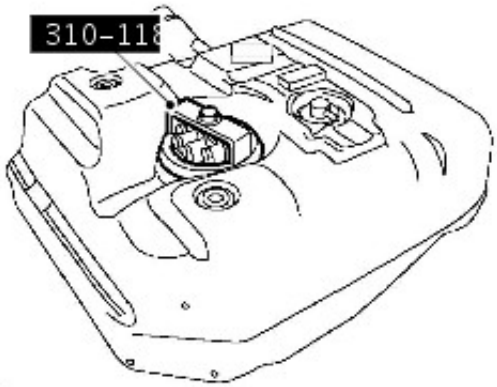
- Using the special tool, remove the locking ring.
- Remove and discard the seal.

Installation

1. NOTE: Clean the component mating faces.

Install the fuel level sender.

- Install a new seal.
- Using the special tool, tighten the locking ring to 35 Nm (26 lb.ft).



E89875

2. Install the fuel tank.
For additional information, refer to: Fuel Tank (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Tank

Removal and Installation

Special Tool(s)	
	Powertrain assembly jack HTJ-1200-02
	Wrench, Fuel tank 310-118

Removal

• WARNINGS:

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Make sure the workshop area in which the vehicle is being worked on is as clean and as dust free as possible. Foreign matter from work on clutches, brakes or from machining or welding operations can contaminate the fuel system and may result in later malfunction.

1. WARNING: Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

Raise and support the vehicle.

2. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and

Connect (414-01 Battery, Mounting and Cables, General Procedures).

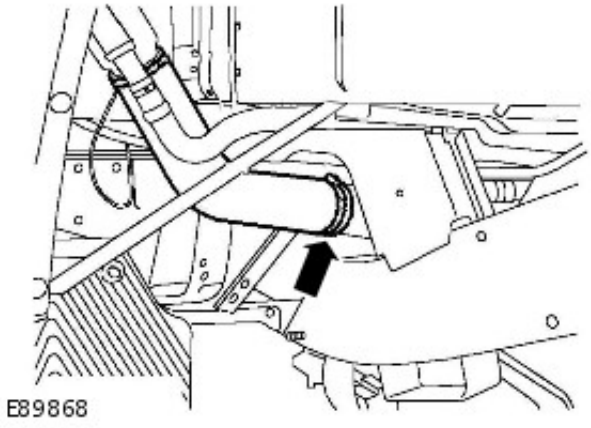
3. WARNING: The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Drain the fuel tank.
For additional information, refer to: Fuel Tank Draining (310-00 Fuel System - General Information, General Procedures).

4. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

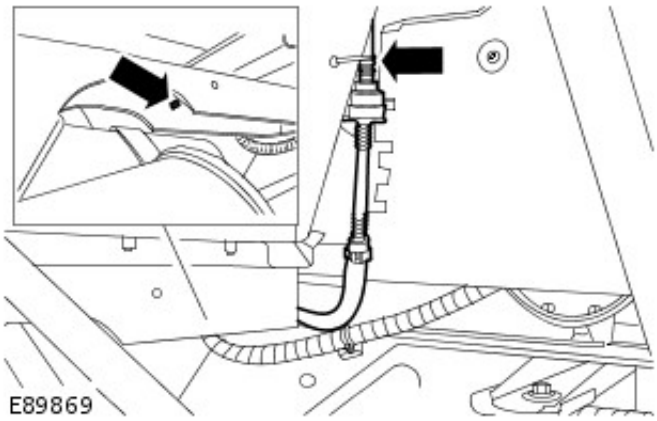
Disconnect the fuel tank filler pipe.

- Loosen the clip.

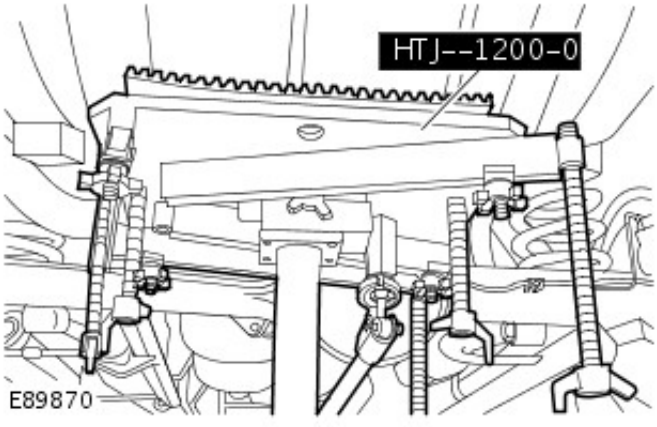


5. Release the fuel tank vent line.

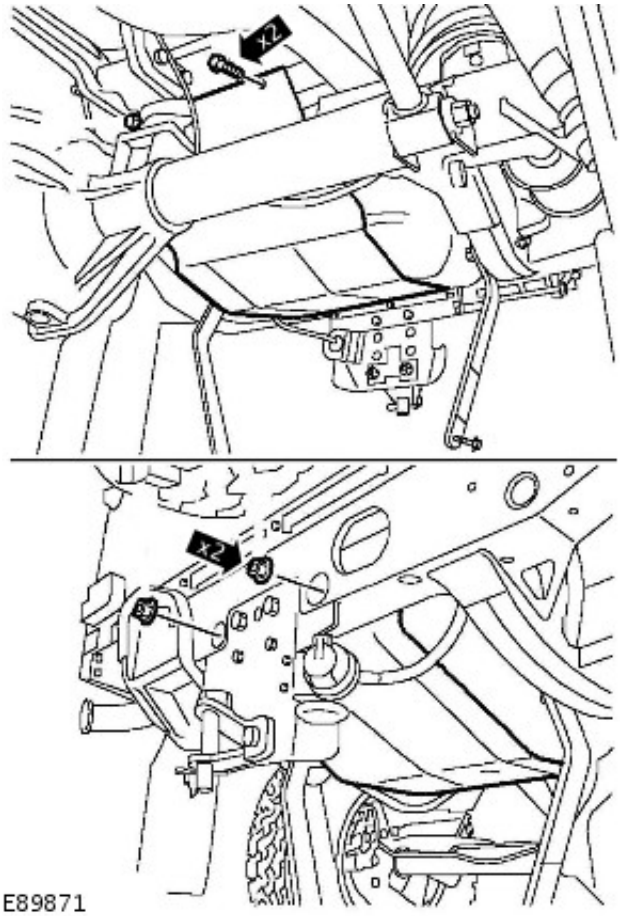
- Release from the clip.
- Cut the cable tie.



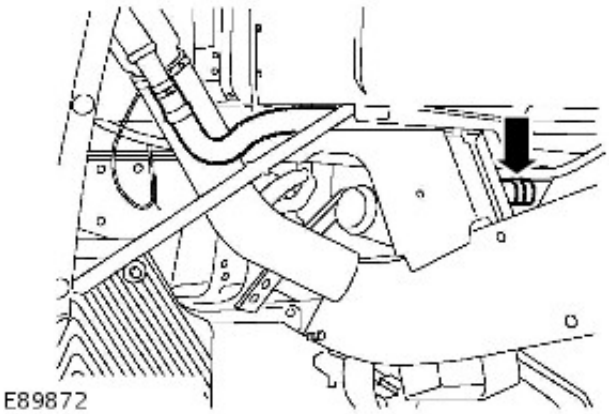
6. Using the special tool, support the fuel tank.



7. Lower the fuel tank.



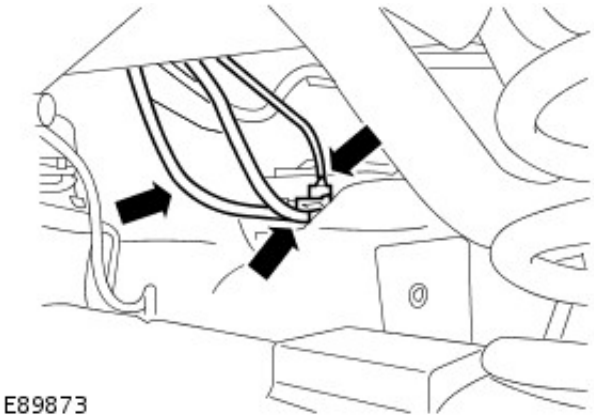
- Remove the 2 bolts.
- Remove the 2 nuts.



8. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the fuel filler pipe breather hose.

- Release the clip.



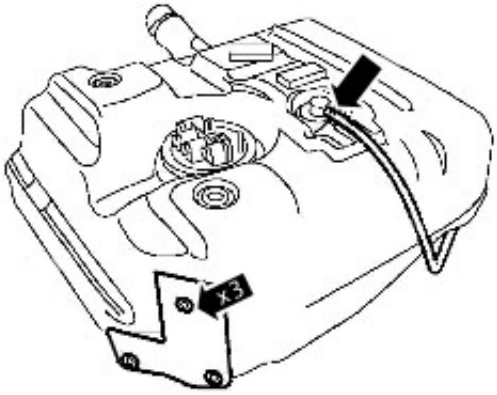
9. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

• NOTE: Note the fitted position of fuel lines.

Remove the fuel tank and the fuel tank support bracket.

- Disconnect the 2 fuel lines.
- Disconnect the electrical connector.

10. NOTE: Do not disassemble further if the component is



E89874

removed for access only.

Remove the fuel tank heat shield.

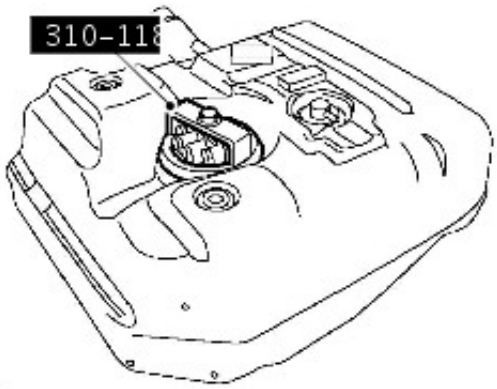
- Remove the 3 clips.

11. Remove the fuel tank vent line.

- Release the clip.

12. Remove the fuel level sender.

- Using the special tool, remove the locking ring.
- Remove and discard the seal.



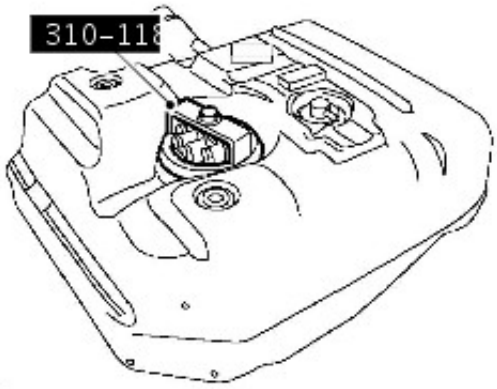
E89875

Installation

1. NOTE: Clean the component mating faces.

Install the fuel level sender.

- Install a new seal.
- Using the special tool, tighten the locking ring to 35 Nm (26 lb.ft).



E89875

2. Install the fuel tank vent line.

- Secure with the clip.

3. Install the fuel tank heat shield.

- Install the 3 clips.

4. NOTE: Remove and discard the blanking caps.

Using the special tool, raise the fuel tank and the fuel tank support bracket.

- Connect the 2 fuel lines.
- Connect the electrical connector.

5. Connect the fuel filler pipe breather hose.

- Secure with the clip.

6. Using the special tool, install the fuel tank and the fuel tank support bracket.

- Tighten the bolts 45 Nm (33 lb.ft).
- Tighten the nuts 25 Nm (18 lb.ft).

7. Secure the fuel tank vent line.

- Secure in the clip.
- Secure with a suitable cable tie .

8. Connect the fuel tank filler pipe.

- Tighten the clip.

9. WARNING: The spilling of fuel is unavoidable during this operation. Make sure that all necessary precautions are taken to prevent fire and explosion.

Refill the fuel tank.

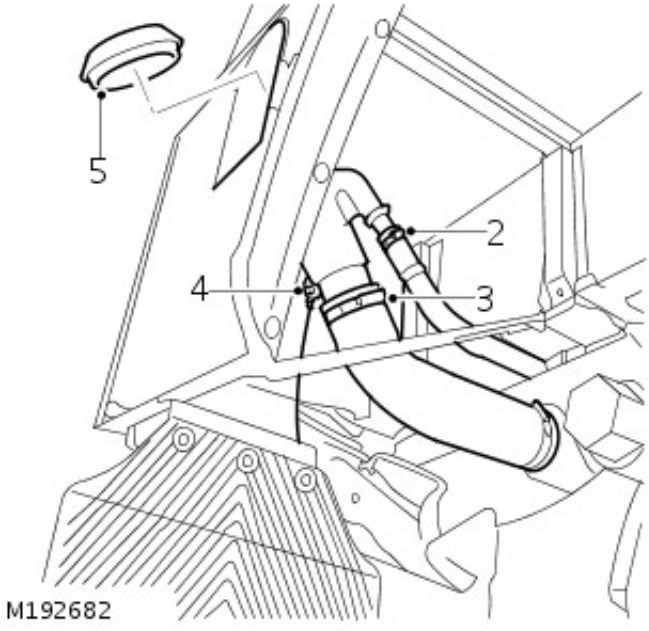
10. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Fuel Tank Filler Pipe

Removal and Installation

Removal

1. Drain fuel tank.
   For additional information, refer to: Fuel Tank Draining (310-00 Fuel System - General Information, General Procedures).
2. Loosen clip securing breather hose to fuel filler neck and release hose.
3. Loosen clip securing fuel filler hose to neck and release hose.
4. Remove screw and release earth lead from filler neck.
5. Remove grommet securing filler neck to body.



6. Remove filler neck from body.

Installation

1. Fit filler neck to body.
2. Coat rubber grommet with soap solution.
3. Fit rubber grommet securing filler neck to body.
4. Connect earth lead and tighten screw.
5. Connect filler hose to neck and tighten clip.
6. Fit breather hose to filler neck and secure with clip.

4: Electrical

Climate Control System - General Information -

General data

Air conditioning	
System type	CFC free expansion valve system
Compressor - V8 & Td5	NipponDenso 10PA17
Compressor - 300TDi	Sanden TRS105N

Fluids and lubricants

Item	
Air conditioning refrigerant type	R134A
Air conditioning refrigerant quantity	
V8	900 g ± 30 g
300 TDi	1100 g ± 50 g
Td5	750 g ± 50 g
Refrigerant oil type	NipponDenso ND-OIL8
Refrigerant oil quantity	180 ml (6.3 fl oz)

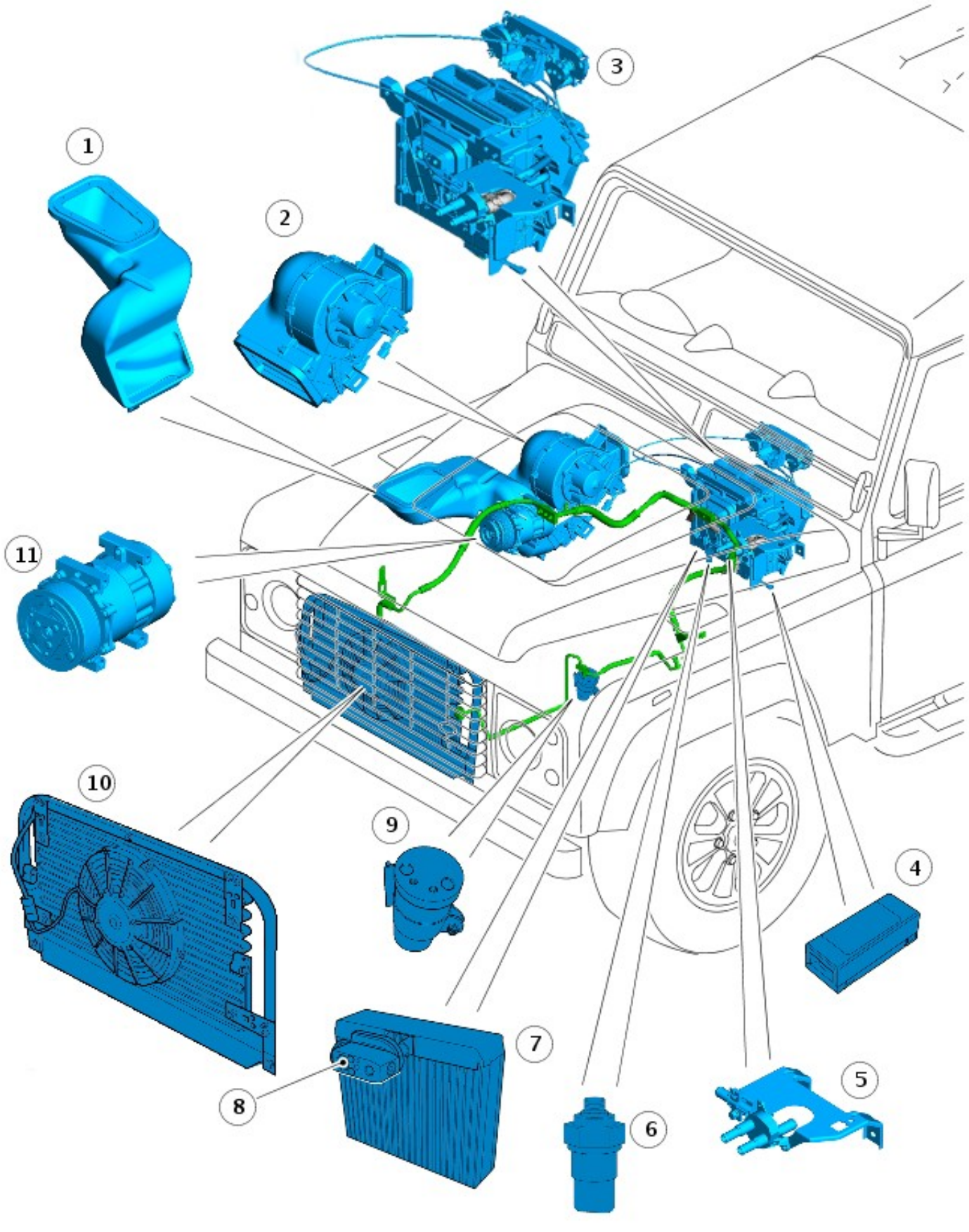
Torque wrench settings

Item	Nm	lbf.ft
Compressor to mounting bracket	25	18
Compressor pipe flange bolts	10	7
Receiver drier union bolts	6	4.5
Pressure cut-off switch	11	8
Pressure pipe union nuts - M16	14	10
Discharge pipe union nuts - M22	22	16
Suction pipe union nuts - M24	33	24

Climate Control System - General Information - Climate Control System
Description and Operation

COMPONENT LOCATION

• NOTE: left-hand drive (LHD) vehicle shown, right-hand drive (RHD) similar.



Item	Part Number	Description
1	-	Air inlet duct
2	-	Air intake and blower assembly
3	-	Heater assembly and controls
4	-	air conditioning (A/C) thermostatic switch
5	-	Water valve and bracket assembly
6	-	A/C refrigerant pressure switch
7	-	A/C evaporator
8	-	A/C thermostatic expansion valve
9	-	A/C receiver drier
10	-	A/C condenser assembly
11	-	A/C compressor

OVERVIEW

The climate control system features heating, and where fitted, A/C operations. Heating selections are made using the left-hand (LH) rotary control mounted on the center console. The rotary control is connected via a Bowden cable to a water valve in the engine cooling system. The water valve allows a varying amount of engine coolant to flow into the heater matrix. The amount of coolant entering the heater matrix determines the heat transferred to the inlet air and thus the amount of heat transferred into the cabin.

Blower motor speed is controlled using a 4 position sliding switch. The switch allows 3 blower motor speeds to be selected by controlling the ground path for the blower motor in conjunction with a resistor pack. The blower motor and resistor pack are both located in the engine compartment.

Air distribution into the cabin is selected using the right-hand (RH) rotary control mounted on the center console. Air intake into the cabin is controlled by a 2 position sliding switch which is also located on the center console.
For additional information, refer to: Air Distribution and Filtering (412-01 Air Distribution and Filtering, Description and Operation).

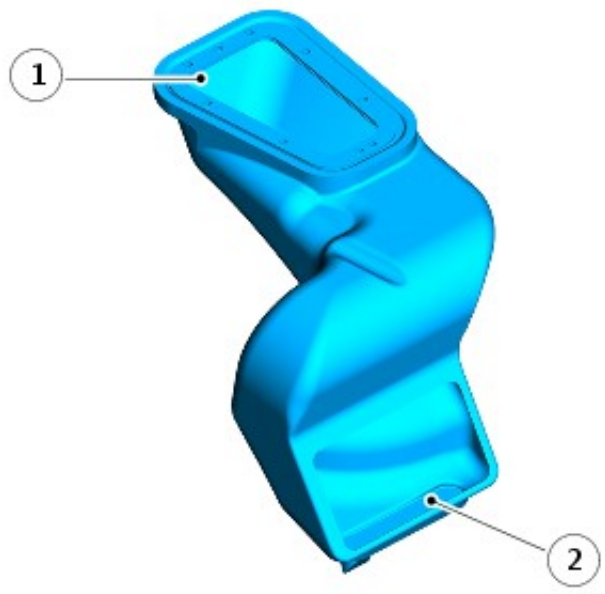
The A/C system is switched on and off using the switch located in the center console. The system will only operate when the engine is running. If A/C is requested when blower motor speed is set to 0, blower motor speed 1 will be engaged automatically.

The engine control module (ECM) monitors the engine running status and suspends A/C operation if necessary by inhibiting the compressor clutch relay.

The heated seats, heated windshield, and heated rear window systems are not part of the climate control system.For additional information, refer to:

Seats (501-10 Seating, Description and Operation),
Glass, Frames and Mechanisms (501-11 Glass, Frames and Mechanisms, Description and Operation).

AIR INLET DUCT



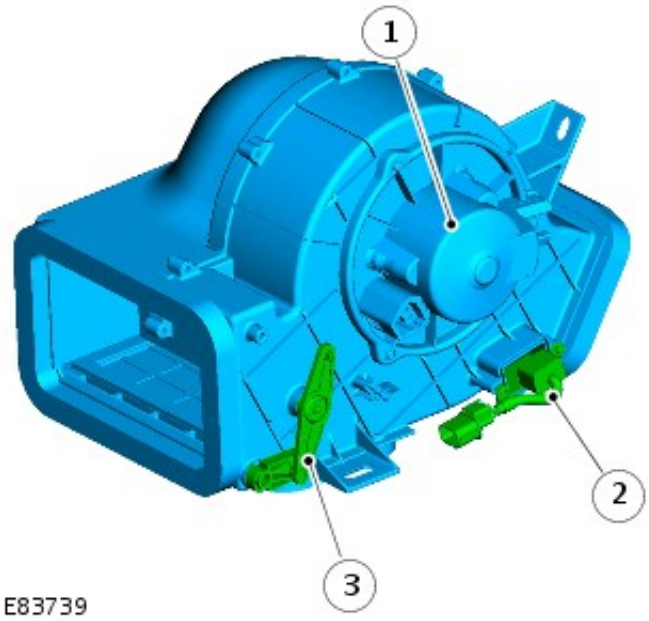
E83738

Item	Part Number	Description
1	-	Air inlet
2	-	Air outlet to blower assembly

The air inlet duct is mounted in the passenger side front fender. Air is drawn into the air inlet duct through a vent on the upper surface of the fender. The air inlet duct directs air into the air intake and blower assembly. The air intake and

blower assembly features a Bowden cable operated flap which allows the user to switch between fresh or recirculated air entering the cabin.

AIR INTAKE AND BLOWER ASSEMBLY

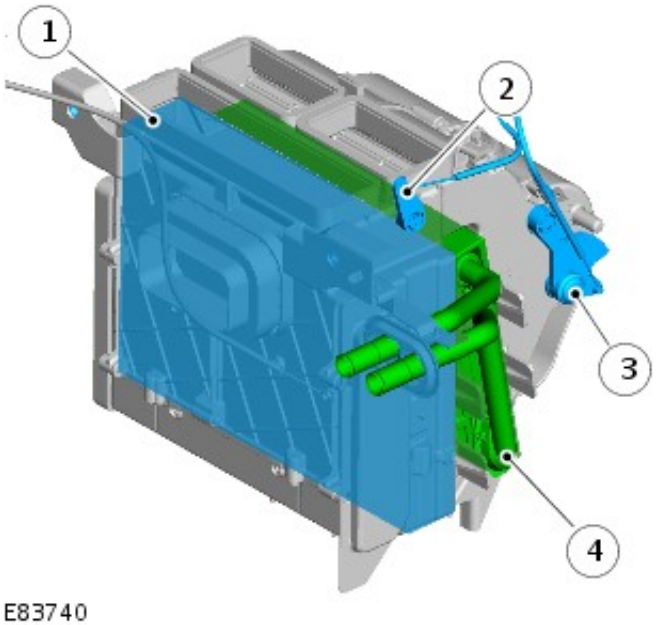


E83739

Item	Part Number	Description
1	-	Blower motor
2	-	Resistor pack
3	-	Fresh/recirculated air flap

The air intake and blower assembly is mounted on the passenger side of the engine compartment. The blower comprises a centrifugal fan powered by an electric motor. The motor is able to operate at 3 speeds, which are controlled by a resistor pack mounted on the inboard side of the blower motor casing. Air leaving the air intake and blower assembly is directed into the rear of the heater assembly.

HEATER ASSEMBLY



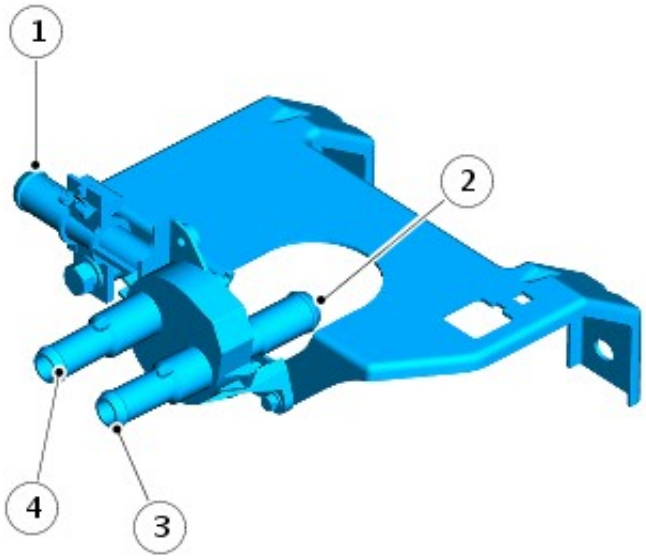
E83740

Item	Part Number	Description
1	-	Diffuser plate
2	-	Windshield/face level air distribution door cam
3	-	Footwell air distribution door cam
4	-	Heater matrix

The heater assembly is mounted behind the instrument panel on the vehicle center line. The heater assembly contains an aluminum heater matrix and a diffuser plate to deliver the required air temperature into the cabin. If the vehicle is fitted with A/C, the A/C evaporator replaces the diffuser plate in the heater assembly.

Air distribution into the cabin is controlled by 2 air distribution doors. The doors are operated via a Bowden cable from the RH rotary control on the center console.

WATER VALVE

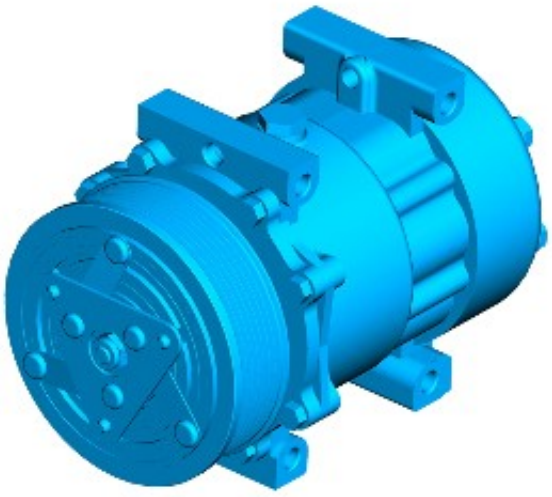


E83741

Item	Part Number	Description
1	-	Return from heater matrix
2	-	Supply to heater matrix
3	-	Supply from engine cooling system
4	-	Return to engine cooling system

The water valve is mounted at the rear of the engine compartment. A Bowden cable acts on a lever on the rear face of the water valve to vary the flow of hot engine coolant into the heater matrix. When the water valve is fully closed, no engine coolant is allowed to flow into the heater matrix. In this instance, engine coolant will flow into the water valve through inlet (3) and immediately out through the return (4).

AIR CONDITIONING COMPRESSOR



E83742

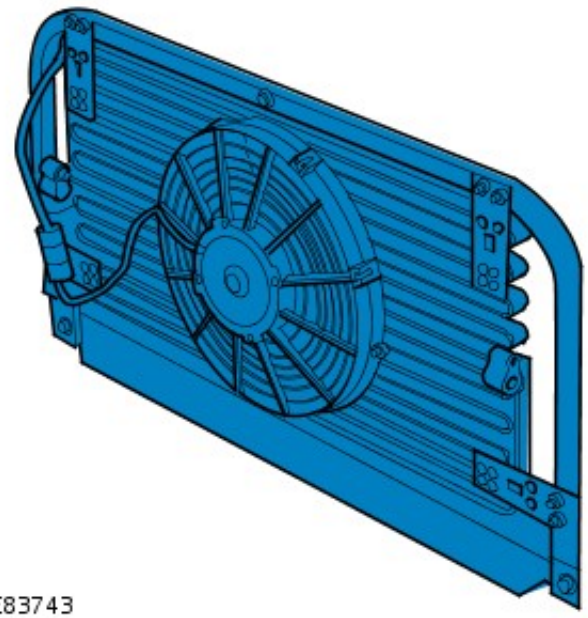
The A/C compressor circulates refrigerant around the system by compressing low pressure, low temperature vapor from the evaporator and discharging the resultant high pressure, high temperature vapor to the condenser.

The A/C compressor is a constant displacement unit which is driven by the engine accessory drive belt. To protect the system from excessive pressure, a pressure relief valve is installed in the outlet side of the A/C compressor. The pressure relief valve vents excess pressure into the engine compartment.

Compressor clutch engagement is controlled by the ECM. The ECM receives system pressure inputs from the refrigerant pressure switch and system temperature inputs from the thermostatic switch. The ECM will de-energize the A/C

compressor clutch relay on receipt of a pressure reading above or below the system limits, or a temperature reading that may cause the evaporator to freeze. For more information, refer to the **'Air Conditioning Refrigerant Pressure Switch'** and **'Thermostatic Switch'** sections below.

AIR CONDITIONING CONDENSER

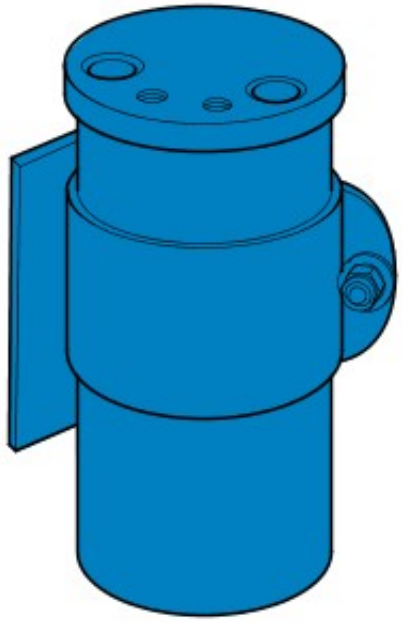


E83743

The condenser transfers heat from the refrigerant to the surrounding air to convert the high pressure vapor from the compressor into a liquid. The condenser is installed immediately in front of the radiator and is held in place by 3 brackets; 1 at the top, 2 at the bottom.

The RH end of the condenser provides a connection to the high pressure line from the A/C compressor. The LH end of the condenser provides a connection to the low pressure line to the receiver drier.

AIR CONDITIONING RECEIVER DRIER

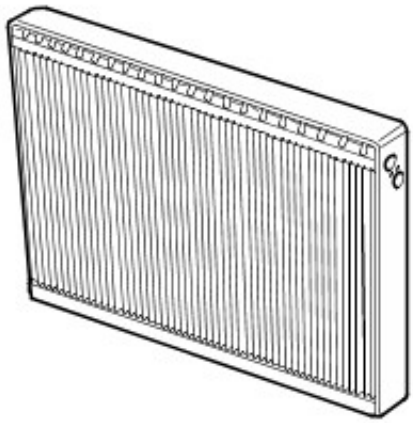


E83744

The receiver drier is mounted in the LH front corner of the engine compartment and removes solid impurities and moisture from the refrigerant. It also provides a reservoir for liquid refrigerant to accommodate changes of heat load at the evaporator.

Refrigerant entering the receiver drier passes through a filter and a desiccant pack, then collects in the base of the unit before flowing through the outlet pipe to the evaporator.

AIR CONDITIONING EVAPORATOR

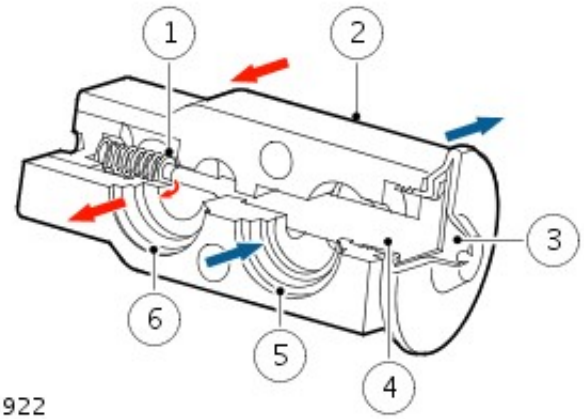


E46923

The evaporator is installed in the heater assembly. Liquid refrigerant enters the evaporator and expands, absorbing large quantities of heat as it changes state to a gas.

Most of the moisture in the air passing through the evaporator condenses into water, which drains out of the vehicle by passing through a drain tube to the underside of the vehicle.

AIR CONDITIONING THERMOSTATIC EXPANSION VALVE



E46922

Item	Part Number	Description
1	-	Metering valve
2	-	Housing
3	-	Diaphragm
4	-	Temperature sensor
5	-	Outlet passage from evaporator
6	-	Inlet passage to evaporator

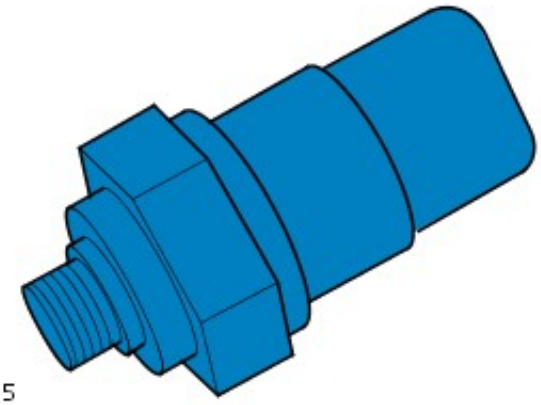
The thermostatic expansion valve meters the flow of refrigerant into the evaporator, to match the refrigerant flow with the heat load of the air passing through the evaporator.

The thermostatic expansion valve is a block type valve located behind the heater assembly, and attached to the inlet and outlet ports of the evaporator. The thermostatic expansion valve consists of an aluminum housing containing inlet and outlet passages. A ball and spring metering valve is installed in the inlet passage and a temperature sensor is installed in the outlet passage. The temperature sensor consists of a temperature sensitive tube connected to a diaphragm. The bottom end of the temperature sensitive tube acts on the ball of the metering valve. Pressure on top of the diaphragm is controlled by the evaporator outlet temperature conducted through the temperature sensitive tube. The bottom of the diaphragm senses evaporator outlet pressure.

Liquid refrigerant flows through the metering valve into the evaporator. The restriction across the metering valve reduces the pressure and temperature of the refrigerant. The restriction also changes the liquid stream of refrigerant into a fine spray, to improve the evaporation process. As the refrigerant passes through the evaporator, it absorbs heat from the air flowing through the evaporator. The increase in temperature causes the refrigerant to vaporize and increase in pressure.

The temperature and pressure of the refrigerant leaving the evaporator acts on the diaphragm and temperature sensitive tube, which regulate the metering valve opening and so control the volume of refrigerant flowing through the evaporator. The warmer the air flowing through the evaporator, the more heat available to evaporate refrigerant and thus the greater volume of refrigerant allowed through the metering valve.

AIR CONDITIONING REFRIGERANT PRESSURE SWITCH


E83745

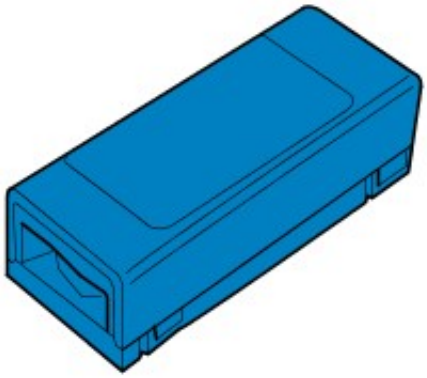
The refrigerant pressure switch is mounted monitors the high pressure side of the A/C system. The switch monitors 3 pressure ranges; high, medium and low. The pressure of refrigerant inside the system is provided to the ECM, which controls operation of the A/C compressor accordingly.

The pressure ranges monitored by the switch are as follows:

Pressure Range	Upper Limit (bar)	Lower Limit (bar)
High	32	6
Medium	15.5	12.5
Low	2.3	2

If the pressure in the system falls below 2 bar, or rises above 32 bar, the ECM will suspend A/C compressor operation by de-energizing the main relay, which subsequently de-energizes the A/C compressor clutch relay.

AIR CONDITIONING THERMOSTATIC SWITCH

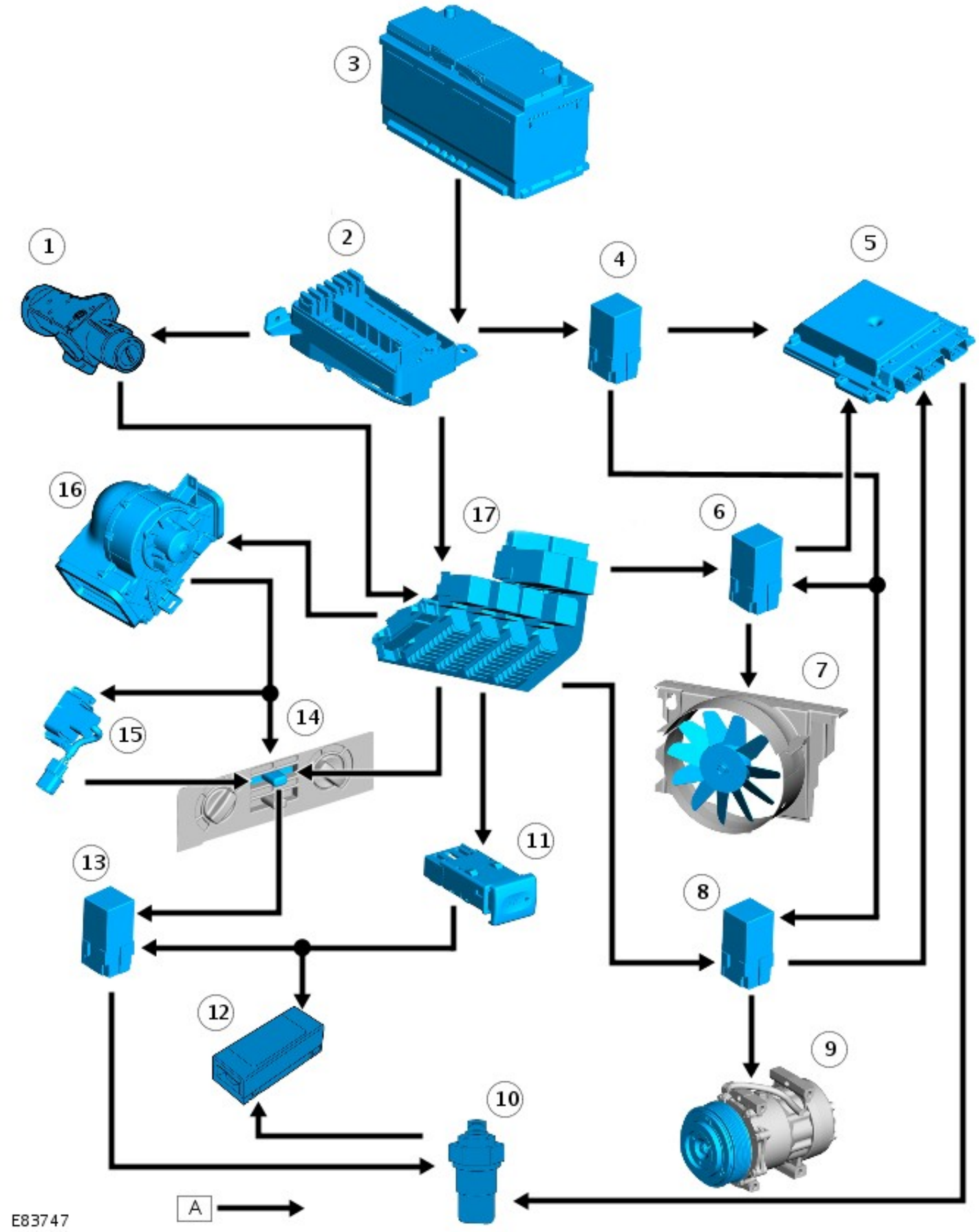

E83746

The thermostatic switch is mounted on the underside of the heater assembly and measures the temperature of the air coming off the A/C evaporator. This temperature value is fed back to the ECM which controls operation of the A/C compressor accordingly.

The ECM will suspend A/C compressor operation if the temperature of the air coming off the evaporator drops to 1°C (34 °F). This prevents the evaporator from freezing. The ECM will re-instate A/C compressor operation when the temperature of the air coming off the evaporator rises to 3.5°C (38°F).

CONTROL DIAGRAM

- NOTE: **A** = Hardwired



Item	Part Number	Description
1	-	Ignition switch
2	-	battery junction box (BJB)
3	-	Battery
4	-	Main relay
5	-	ECM
6	-	Cooling fan relay

7	-	Cooling fan
8	-	A/C compressor clutch relay
9	-	A/C compressor clutch
10	-	A/C refrigerant pressure switch
11	-	A/C switch
12	-	A/C thermostatic switch
13	-	Blower motor relay
14	-	Blower motor switch
15	-	Blower motor resistor pack
16	-	Blower motor
17	-	central junction box (CJB)

PRINCIPLES OF OPERATION

Heating

Heating control is achieved by varying the amount of engine coolant fed into the heater matrix. Coolant is bled from the engine cooling system and fed into the heater matrix through the water valve. The water valve is operated via a Bowden cable from the rotary heater control and varies the amount of engine coolant entering the heater matrix in response to heating demand.

If partial heating is requested, a proportion of engine coolant is returned back to the engine cooling system. If no heating is requested, the water valve returns all engine coolant back to the engine cooling system, by-passing the heater matrix.

Heat is transferred to the inlet air as it passes through the heater matrix. The heated air is then delivered into the cabin through a series of ducts, vents, and registers.
For additional information, refer to: Air Distribution and Filtering (412-01 Air Distribution and Filtering, Description and Operation).

Air Conditioning

The A/C system transfers heat from the cabin to the outside atmosphere to provide dehumidified cool air. The A/C system is a sealed closed loop system, filled with a charge weight of R134a refrigerant as the heat transfer medium. Oil is added to the refrigerant to lubricate the internal components of the A/C compressor.

Hot, high pressure gas from the compressor flows into the condenser, which allows heat to dissipate causing the gas to condense into a liquid form. The flow of liquid refrigerant into the evaporator is controlled by the thermostatic expansion valve. When in the evaporator the liquid refrigerant expands and absorbs heat from its surroundings, cooling the fins and plates of the A/C evaporator. As inlet air passes across the A/C evaporator surface it is cooled before entering the cabin through a series of ducts, vents, and registers.
For additional information, refer to: Air Distribution and Filtering (412-01 Air Distribution and Filtering, Description and Operation).

Climate Control System - General Information - Climate Control System

Diagnosis and Testing

GENERAL PRECAUTIONS

The refrigerant used in the air conditioning system is HFC (Hydrofluorocarbon) R134a.

• WARNINGS:

R134a is a hazardous liquid and when handled incorrectly can cause serious injury. Suitable protective clothing must be worn when carrying out servicing operations on the air conditioning system.

R134a is odourless and colourless. Do not handle or discharge in an enclosed area, or in any area where the vapour or liquid can come in contact with naked flame or hot metal. R134a is not flammable, but can form a highly toxic gas.

Do not smoke or weld in areas where R134a is in use. Inhalation of concentrations of the vapour can cause dizziness, disorientation. uncoordination, narcosis, nausea or vomiting.

Do not allow fluids other than R134a or compressor lubricant to enter the air conditioning system. Spontaneous combustion may occur.

R134a splashed on any part of the body will cause immediate freezing of that area. Also refrigerant cylinders and replenishment trolleys when discharging will freeze skin to them if contact is made.

The refrigerant used in an air conditioning system must be reclaimed in accordance with the recommendations given with a Refrigerant Recovery Recycling Recharging Station.

• NOTE: Suitable protective clothing comprises: Wrap around safety glasses or helmet, heatproof gloves, rubber apron or waterproof overalls and rubber boots.

Routine servicing, apart from visual checks, is not necessary. The visual inspections are as follows:

Condenser

With a water hose or air line, clean the fins of the condenser to remove flies, leaves, etc. Check the pipe connections for signs of oil leakage.

Compressor

Check pipe connections for signs of oil leakage. Check flexible hoses for swelling. Examine the compressor belt for tightness and condition.

Sight glass

Examine the sight glass for bubbles with the system operating. Check connections for leakage.

Evaporator

Examine the refrigeration connections at the unit.

REMEDIAL ACTIONS

• WARNINGS:

Do not allow a refrigerant container to be heated by a direct flame or to be placed near any heating appliance. A refrigerant container must not be heated above 50° C.

Do not leave a container of refrigerant without its cap fitted. Do not transport a container of refrigerant that is unrestrained, especially in the boot of a car.

• NOTE: Due to its low evaporating temperature of -30° C, R134a should be handled with care.

- If liquid R134a strikes the eye, do not rub it. Gently run large quantities of eyewash over the eye to raise the temperature. If eyewash is not available cool, clean water may be used. Cover eye with clean pad and seek immediate medical attention.
- If liquid R134a is splashed on the skin run large quantities of water over the area as soon as possible to raise the temperature. Carry out the same actions if skin comes into contact with discharging cylinders. Wrap affected parts in blankets or similar material and seek immediate medical attention.
- If suspected of being overcome by inhalation of R134a vapour, seek fresh air. If unconscious remove to fresh air.

Apply artificial respiration and/or oxygen and seek immediate medical attention.

SERVICING PRECAUTIONS

Care must be taken when handling refrigeration system components. Units must not be lifted by their hoses, pipes or capillary lines. Hoses and lines must not be subjected to any twist or stress. Ensure that hoses are positioned in their correct run before fully tightening the couplings, and ensure that all clips and supports are used. Torque wrenches of the correct type must be used when tightening refrigerant connections to the stated value. An additional spanner must be used to hold the union to prevent twisting of the pipe.

Before connecting any hose or pipe ensure that refrigerant oil is applied to the seat of the new '0' ring but not to the threads.

Check the oil trap for the amount of oil lost.

All protective plugs on components must be left in place until immediately prior to connection.

The receiver/drier contains desiccant which absorbs moisture. It must be positively sealed at all times.

CAUTION: Whenever the refrigerant system is opened, the receiver/drier must be renewed immediately before evacuating and recharging the system.

Use alcohol and a clean cloth to clean dirty connections. Ensure that all new parts fitted are marked for use with R134a.

Refrigerant oil

Use the approved refrigerant lubricating oil - Nippon Denso ND-OIL 8.

CAUTION: Do not use any other type of refrigerant oil.

Refrigerant oil easily absorbs water and must not be stored for long periods. Do not pour unused oil back into the container. When renewing system components, add the following quantities of refrigerant oil:

Component	Fluid quantity
Condenser	40ml
Evaporator	80ml
Pipe or hose	20ml
Receiver/drier	20ml
Total quantity of refrigerant oil in system	140ml

A new compressor is sealed and pressurised with Nitrogen gas, slowly release the sealing cap, gas pressure should be heard to release as the seal is broken.

• NOTE: A new compressor should always have its sealing caps in place and these must not be removed until immediately prior to fitting

A new compressor is supplied with an oil fill of 140ml.

A calculated quantity of oil must be drained from a new compressor before fitting.

To calculate the quantity of oil to be drained:

- Remove sealing plugs from the OLD compressor.
- Invert compressor and gravity drain oil into measuring cylinder. Rotating the compressor clutch plate will assist complete draining.
- Note the quantity of oil drained (Yml).
- Calculate the quantity (Qml) of oil to be drained from the NEW compressor using the following formula: Xml - (Yml + 20ml) = Qml

Rapid refrigerant discharge

When the air conditioning system is involved in accident damage and the circuit is punctured, the refrigerant is discharged rapidly. The rapid discharge of refrigerant will also result in the loss of most of the oil from the system. The compressor must be removed and all the remaining oil in the compressor drained and refilled as follows:

- Gravity drain all the oil, assist by rotating the clutch plate (not the pulley).
- Refill the compressor with 90ml of new refrigerant oil.
- Plug the inlet and outlet ports.

Servicing Equipment

The following equipment is required for full servicing of the air conditioning system.

Recovery, recycling and charging station Leak detector Thermometer +20° C to -60° C Safety goggles and gloves

Precautions when handling refrigerant lines

WARNING: Wear eye and hand protection when disconnecting components containing refrigerant. Plug all exposed connections immediately.

- When disconnecting any hose or pipe connection the system must be discharged of all pressure. Proceed cautiously, regardless of gauge readings. Open connections slowly, keeping hands and face well clear, so that no injury occurs if there is liquid in the line. If pressure is noticed, allow it to bleed off slowly.
- Lines, flexible end connections and components must be capped immediately they are opened to prevent the entrance of moisture and dirt.
- Any dirt or grease on fittings must be wiped off with a clean alcohol dampened cloth. Do not use chlorinated solvents such as trichloroethylene. If dirt, grease or moisture cannot be removed from inside the hoses, they must be replaced with new hoses.
- All replacement components and flexible end connections must be sealed, and only opened immediately prior to making the connection.
- Ensure the components are at room temperature before uncapping, to prevent condensation of moisture from the air that enters.
- Components must not remain uncapped for longer than 15 minutes. In the event of delay, the caps must be fitted.
- Receiver/driers must never be left uncapped as they contain Silica Gel crystals which will absorb moisture from the atmosphere. A receiver/ drier left uncapped must not be used, fit a new unit.
- The compressor shaft must not be rotated until the system is entirely assembled and contains a charge of refrigerant.
- A new compressor contains an initial charge of refrigerant oil. The compressor also contains a holding charge of gas when received which should be retained by leaving the seals in place until the pipes are re-connected.
- The receiver/drier should be the last component connected to the system to ensure optimum dehydration and maximum moisture protection of the system.
- All precautions must be taken to prevent damage to fittings and connections. Slight damage could cause a leak with the high pressures used in the system.
- Always use two wrenches of the correct size, one on each fitting when releasing and tightening refrigeration unions.
- Joints and 'O' rings should be coated with refrigeration oil to aid correct seating. Fittings which are not lubricated with refrigerant oil are almost certain to leak.
- All lines must be free of kinks. The efficiency of the system is reduced by a single kink or restriction.
- Flexible hoses should not be bent to a radius less than 90mm radius.
- Flexible hoses should not be within 100mm of the exhaust manifold.
- Completed assemblies must be checked for refrigeration lines touching metal panels. Any direct contact of lines and panels transmits noise and must be eliminated.

PERFORMANCE TEST

WARNING: R134A is hazardous.
REFER to: Health and Safety Precautions (100-00 General Information, Description and Operation).

Carry out this test with hood and doors or windows open, air conditioning switched on, temperature control set to cold and blower at maximum speed. Set the air supply control to supply fresh air.

1. **1.** Close low pressure valve on refrigerant station.
2. **2.** Close high pressure valve on refrigerant station.
3. **3.** Connect a Refrigerant Station to the high and low pressure servicing connections.
4. **4.** Insert dry bulb thermometer into cold air outlet and position dry and wet bulb thermometer close to outside air inlet. Do not spill water from the wet thermometer (psychrometer).
5. **5.** Start engine and run it at 1500 rev/min for 10 minutes with air conditioning switched on.
6. **6.** Read both pressure gauges and thermometers. Check readings against table below with humidity between 60% and 80%.
7. **7.** Switch off air conditioning, stop engine, disconnect test equipment.

Performance range

Intake temperature	Outlet temperature	Low pressure	High pressure
68°F	41 - 50°F	20 - 23 lbf/in²	116 - 190 lbf/in²
20°C	5 - 10°C	1.4 - 1.6 bar	8.0 - 13 bar
75°F	45 - 60°F	21 - 28 lbf/in²	130 - 200 lbf/in²
25°C	7 - 15°C	1.5 - 2.0 bar	9.0 - 14 bar
85°F	46 - 68°F	26 - 40 lbf/in²	190 - 230 lbf/in²
30°C	8 - 20°C	1.8 - 2.8 bar	13 - 16 bar
95°F	52 - 72°F		
35°C	11 - 22°C	2.5 - 3.5 bar	16 - 19 bar

Ambient temperature		Compound gauge readings		High pressure gauge readings	
°C	°F	bar	lbf/in²	bar	lbf/in²

16	60	1,3-1,4	15-20	6,9-10,3	100-150
27	80	1,4-1,7	20-25	9,7-13,1	140-190
38	100	1,7-2,1	25-30	12,4-15,5	180-225
43	110	2,1-2,4	30-35	14,8-17,2	215-250

Climate Control System - General Information - Air Conditioning (A/C) System Recovery, Evacuation and Charging

General Procedures

• WARNINGS:

The air conditioning system is charged with a high pressure, potentially toxic refrigerant. Repairs or servicing must only be carried out by an operator familiar with both the vehicle system and the charging and testing equipment. All operations must be carried out in a well-ventilated area away from open flame and heat sources. Always wear safety goggles and gloves when opening refrigerant connections.

Wear eye and hand safety protection. Open connections slowly in case liquid or pressure is present. Allow to bleed off slowly.

CAUTION: Overcharging air conditioning system will cause excessive head pressure.

1. Remove dust caps from high and low pressure connectors.

2. Connect high and low pressure hoses to appropriate connections.

3. Open valves on connectors.

4. Turn valves on refrigerant station to correct positions.

5. Turn Process switch to correct position.

6. Turn Main switch to 'ON'.

7. Allow refrigerant station to recover refrigerant from system.

8. Close valves on refrigerant station.

9. Turn Main switch to 'OFF'.

10. Close valves on connectors.

11. Disconnect high and low pressure hoses from connectors.

12. Fit dust caps to connectors.

13. Open tap at rear of station to drain refrigerant oil recovered from system.

14. Measure and record quantity of refrigerant oil recovered from system.

15. Close tap at rear of station.

16. WARNING: Refrigerant must always be recycled before reuse, to ensure that the purity of the refrigerant is high enough for safe use in the air conditioning system. Recycling should always be carried out with equipment which is design certified by Underwriter Laboratory Inc. for compliance with SAE-J1991. Other equipment may not recycle refrigerant to the required level of purity. A R134a Refrigerant Recovery Recycling Recharging Station must not be used with any other type of refrigerant. Refrigerant R134a from domestic and commercial sources must not be used in motor vehicle air conditioning systems.

Measure the quantity of oil discharged from the system. Add an equal amount of new refrigerant oil to compressor before evacuation sequence.

17. CAUTIONS:

When a major repair has been carried out, a leak test should be carried out using inert gas.

Whenever the refrigerant system is opened, the receiver/drier must be renewed immediately before evacuating and recharging the system.

Renew the receiver/drier.

18. Remove dust caps from high and low pressure connectors.

19. Connect high and low pressure hoses to appropriate connections.

20. Open valves on connectors.

21. Turn valves on refrigerant station to correct positions.

22. Turn Process switch to correct position.

23. Turn Main switch to 'ON'.

24. Allow refrigerant station to evacuate system.

CAUTION: The system must be Evacuated immediately before recharging commences. Delay between Evacuation and Recharging is not permitted.

25. If the vacuum reading is below 700 mm Hg, 28 in Hg after 15 minutes, suspect a leak in the system. Partially recharge the system and check for leaks using an electronic leak tester. Check suction lines first, then run the compressor for 5 minutes and then check the high pressure lines.

26. WARNINGS:

A R134a Refrigerant Recovery Recycling Recharging station must not be used with any other type of refrigerant.

R134a refrigerant from domestic and commercial sources must not be used in motor vehicle air conditioning systems.

CAUTION: When a major repair has been carried out, a leak test should be carried out using inert gas.

Close valves on refrigerant station.

27. Close valve on oil charger.

28. Disconnect yellow hose from refrigerant station.

29. Remove lid from oil charger.

30. Pour correct quantity of refrigerant oil into oil charger.

31. Fit lid to oil charger.

32. Connect yellow hose to refrigerant station.

33. Open valve on oil charger.

34. Move pointer on refrigerant gauge to mark position of refrigerant drop.

35. Slowly open correct valve on refrigerant station and allow vacuum to pull refrigerant into system.

36. Close valve on refrigerant station when correct amount of refrigerant has been drawn into air conditioning system.

37. If the full charge is not accepted by the system, start the engine and run it at 1,500 rev/min for a minimum of 2 minutes. Switch on the air conditioning system, open the vehicle windows, set the temperature control to cold and the blower switch to maximum.

38. Consult Refrigerant station instruction manual for correct procedure to complete the charge.

39. Turn Main switch to 'OFF'.

40. Close valves on connectors.

41. Disconnect high and low pressure hoses from connectors.

42. Fit dust caps to connectors.

43. Carry out performance test on air conditioning system.

Climate Control System - General Information - Refrigerant System Tests

General Procedures

1. Place the vehicle in a ventilated, shaded area free from excessive draught, with the doors and windows open.
2. Check that the surface of the condenser is not restricted with dirt, leaves, flies, etc. Do not neglect to check the surface between the condenser and the radiator. Clean as necessary.
3. Switch on the ignition and the air conditioner air flow control. Check that the blower is operating efficiently at low, medium and high speeds. Switch off the blower and the ignition.
4. Check that the evaporator drain tube is open and clear.
5. Check the tension of the compressor driving belt, and adjust if necessary.
6. Inspect all connections for the presence of refrigerant oil. If oil is evident, check for leaks, and repair as necessary.

• NOTE: The compressor oil is soluble in Refrigerant R134a and is deposited when the refrigerant evaporates from a leak.

7. Start the engine.
8. Set the temperature controls to cold and switch the air conditioner blower control on and off several times, checking that the magnetic clutch on the compressor engages and releases each time.
9. With the temperature control at maximum cooling and the blower control at high speed, warm up the engine and fast idle at 1000 rev/min.
10. Repeat at 1800 rev/min.
11. Gradually increase the engine speed to the high range and check the sight glass at intervals.
12. Check for frosting on the service valves.
13. Check the high pressure hoses and connections by hand for varying temperature. Low temperature indicates a restriction or blockage at that point.
14. Switch off the air conditioning blower and stop the engine.
15. If the air conditioning equipment is still not satisfactory, carry out a pressure test as previously described in this section.

Climate Control System - General Information - Electronic Leak Detection

General Procedures

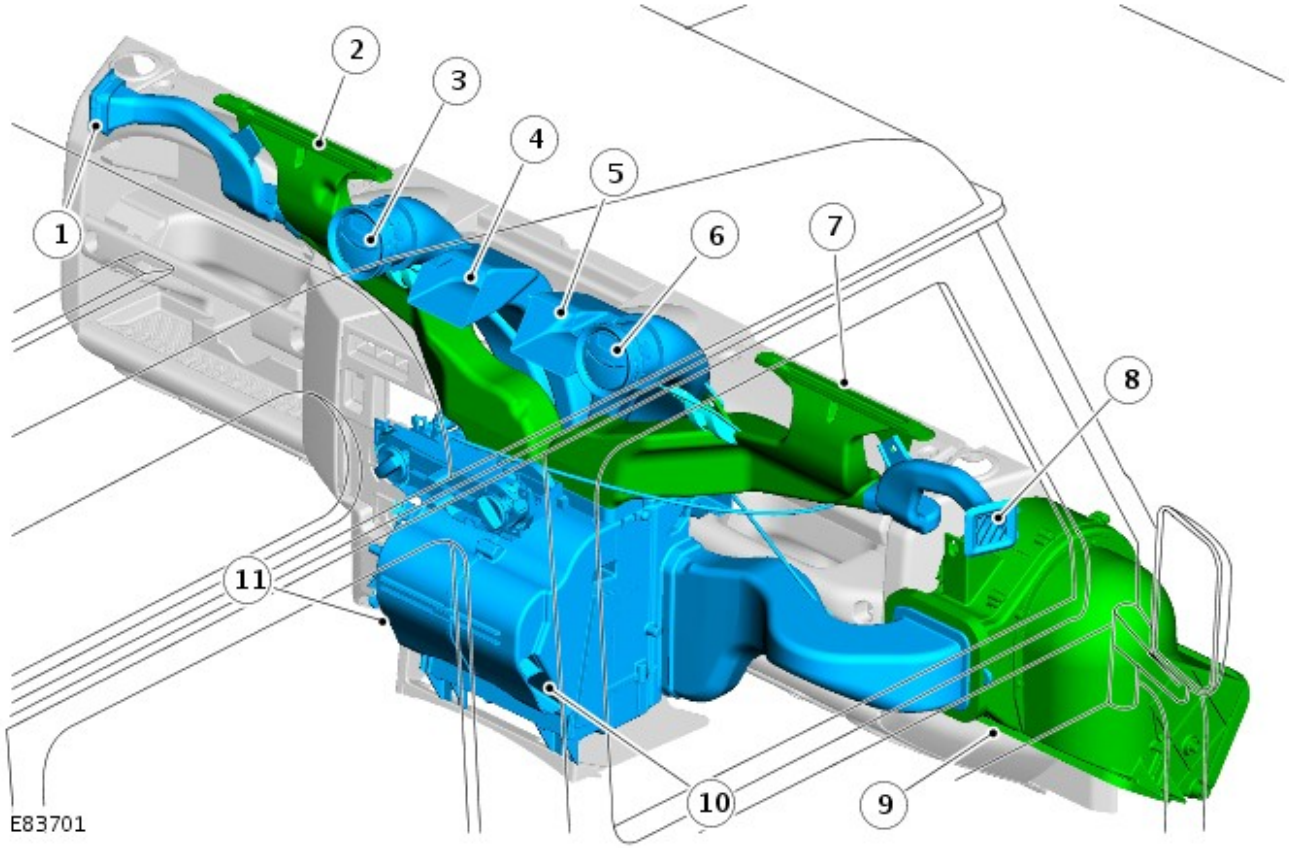
CAUTION: When a major repair has been carried out, a leak test should be carried out using an inert gas (see below).

1. Place the vehicle in a well ventilated area but free from draughts, as leakage from the system could be dissipated without detection.
2. Follow the instructions issued by the manufacturer of the particular leak detector being used.
3. Commence searching for leaks by passing the detector probe around all joints and components, refrigerant gas is heavier than air.
4. Insert the probe into an air outlet of the evaporator or into the evaporator drain tube. Switch the air conditioning blower on and off at intervals of ten seconds. Any leaking refrigerant will be gathered in by the blower and detected.
5. Insert the probe between the magnetic clutch and compressor to check the shaft seal for leaks.
6. Check all service valve connections, valve plate, head and base plate joints and back seal plate.
7. Check the condenser for leaks at the pipe unions.
8. If any leaks are found, the system must be discharged before rectification.
9. Rectify any leaks and recheck for leaks during evacuation prior to charging.
10. **Leak test using inert gas**
    1. Connect gas line to recharging station.
    2. Pressurise system to 3 bar (45 lbf/in²).
    3. Carry out leak test as above.

Air Distribution and Filtering - Air Distribution and Filtering
Description and Operation

COMPONENT LOCATION

• NOTE: left-hand drive (LHD) vehicle shown, right-hand drive (RHD) similar.



Item	Part Number	Description
1	-	left-hand (LH) side window vent
2	-	Windshield LH vent
3	-	LH face level register
4	-	LH face level vent
5	-	right-hand (RH) face level vent
6	-	RH face level register
7	-	Windshield RH vent
8	-	RH side window vent
9	-	Recirculated air inlet
10	-	RH footwell vent
11	-	LH footwell vent

OVERVIEW

Air intake into the cabin is controlled using a 2 position sliding switch located on the center console. Either fresh or recirculated air can be selected. Selections are transmitted to the air intake and blower assembly using a Bowden cable. The air intake and blower assembly is located in the engine compartment.

Fresh air enters the system through the air inlet duct mounted in the passenger side front fender. Inlet air travels through the air intake and blower assembly to the heater assembly where it is distributed into the front of the cabin via a series of ducts, registers and vents.

• NOTE: The vehicle is not fitted with a pollen filter.

When selected, recirculated air enters the system through an inlet located in the lower surface of the instrument panel, above the passenger foot well.

Air distribution into the cabin is selected using the RH rotary control mounted on the center console. A Bowden cable transmits selections to 2 air distribution doors using cams mounted on the heater assembly.

For additional information, refer to: Climate Control System (412-00 Climate Control System - General Information, Description and Operation).

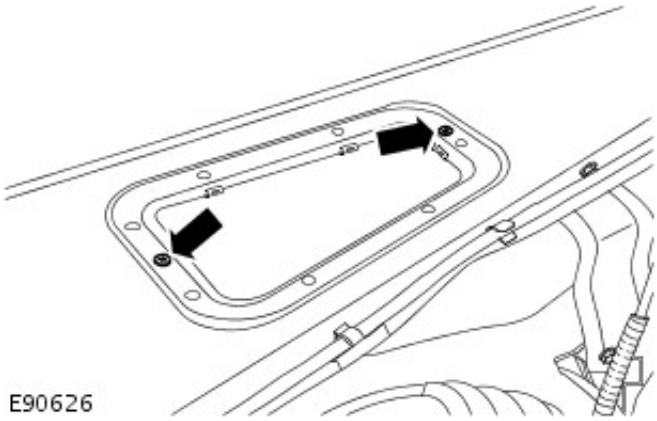
Air Distribution and Filtering - Air Inlet Duct

Removal and Installation

Removal

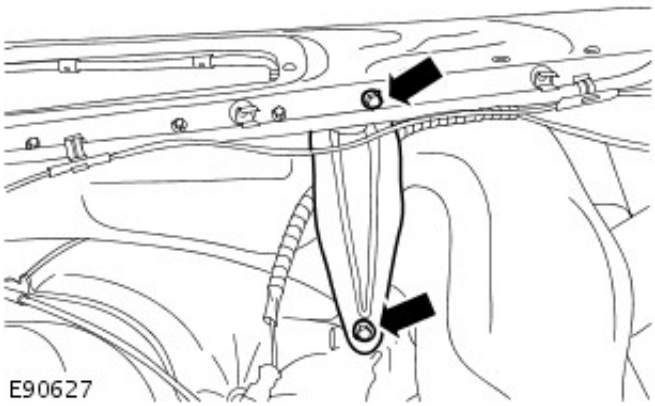
1. Remove the air inlet grille.

- Remove the 7 screws.



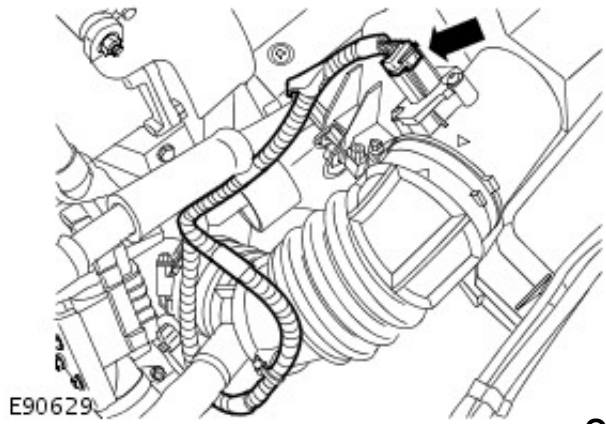
2. Release the air inlet duct.

- Remove the 2 screws.

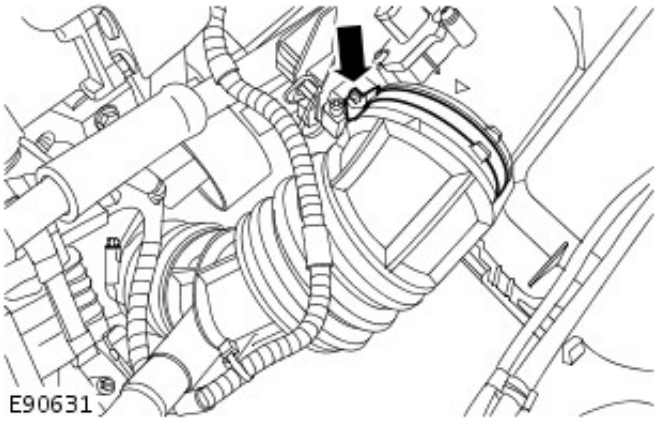


3. Remove the fender support bracket.

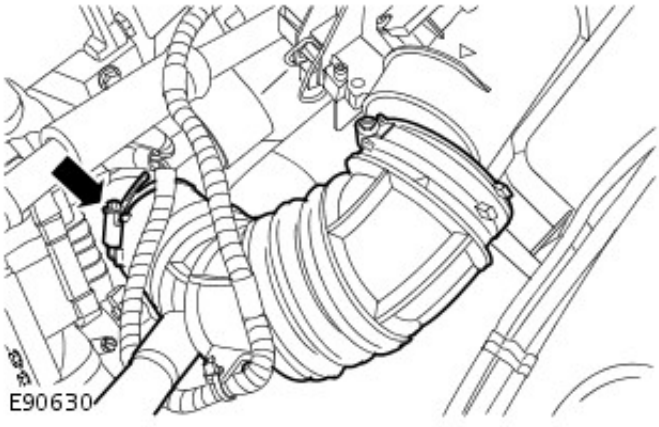
- Remove the 2 bolts.



4. Disconnect the mass air flow (MAF) sensor electrical connector.

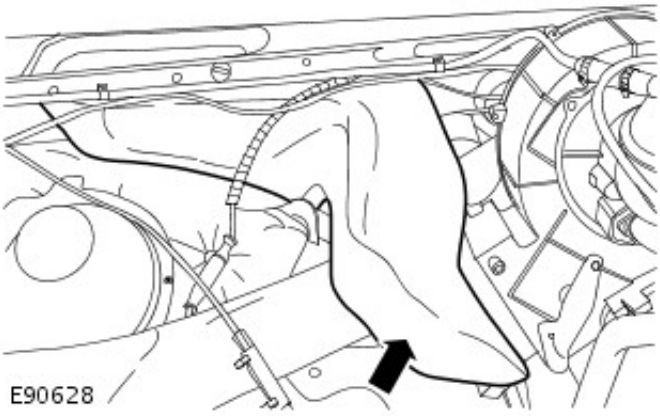


5. Release the air cleaner outlet pipe clip.



6. Release the air cleaner outlet pipe.

- Release the clip.



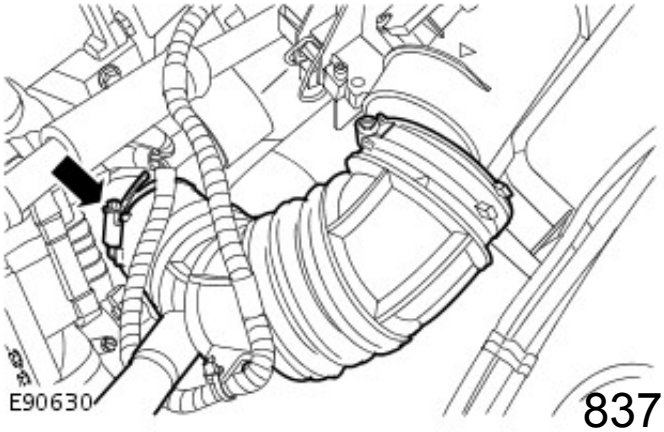
7. Remove the air inlet duct.

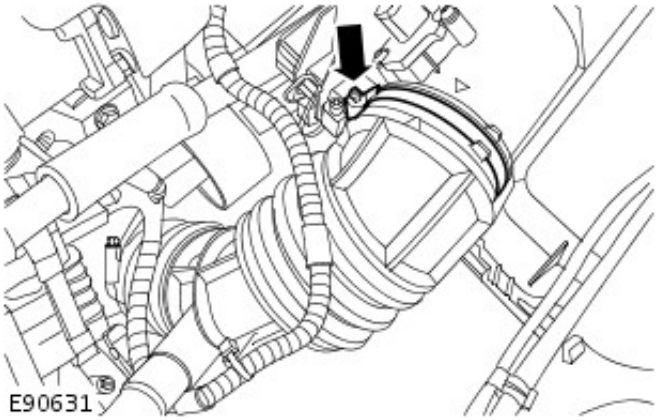
Installation

1. NOTE: To prevent water ingress, make sure the air inlet duct is correctly aligned with the blower motor seal.

To install, reverse the removal procedure.

2. Tighten to 3 Nm (2 lb.ft).





3. Tighten to 3 Nm (2 lb.ft).

Air Distribution and Filtering - Instrument Panel Registers

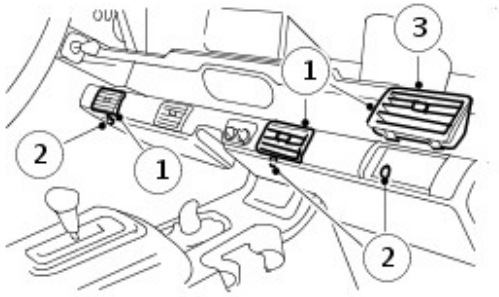
Removal and Installation

Removal

1. Lever under each bottom corner and remove cold air vents from instrument panel registers.

2. Remove screw securing underside of instrument panel registers to panel.

3. Remove 3 screws securing inside of instrument panel registers to panel.



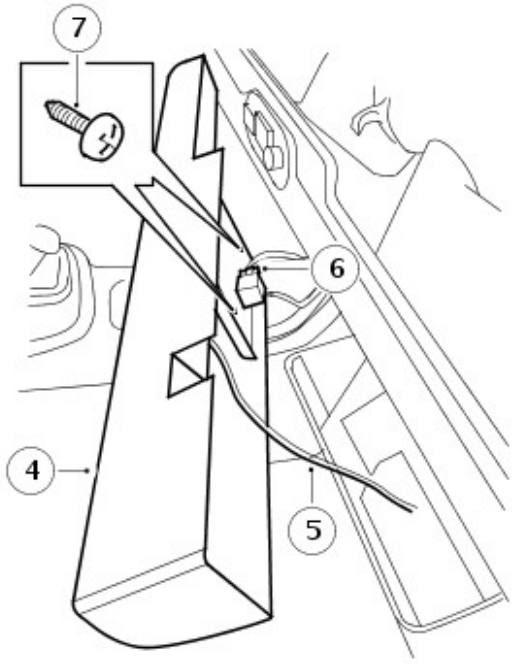
82M0428

4. Lift instrument panel registers away from evaporator casing.

5. Withdraw capillary tube from evaporator fins.

6. Disconnect multiplug from fan interlock relay.

7. Remove 2 screws securing cover to rear of instrument panel registers.

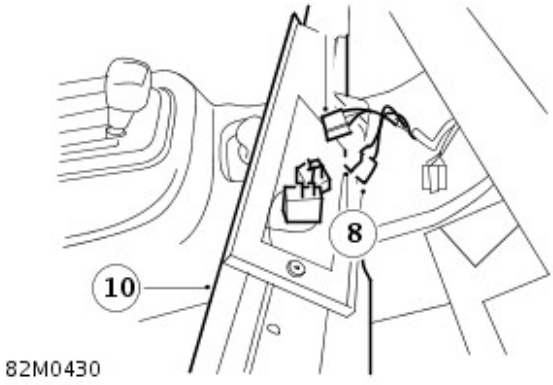


82M0429

8. Release 2 connectors from temperature control switch.

9. Disconnect multiplug from fan switch.

10. Remove instrument panel registers.



82M0430

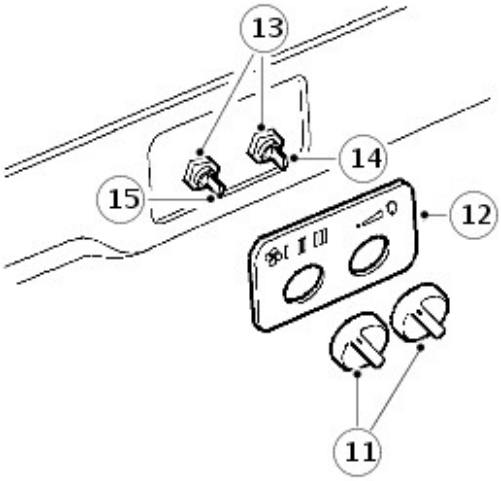
11. Pull control knobs from switches.

12. Remove switch panel.

13. Remove nuts securing switches to instrument panel registers.

14. Remove temperature control switch.

15. Remove fan switch.



82M04314A

16. Transfer components to new instrument panel registers.

Installation

1. Position instrument panel registers assembly and connect multiplug to fan switch.

2. Fit connectors to temperature control switch.

3. Position capillary tube to RH side of instrument panel registers.

4. Fit screws securing cover to rear of instrument panel registers.

5. Connect multiplug to fan interlock relay.

6. Position instrument panel registers and insert capillary tube 60 mm (2.5 in) into evaporator fins.

7. Fit instrument panel registers to panel and above evaporator casing, secure with screws.

8. Fit cold air vents.

9. Carry out system test.
For additional information, refer to: Refrigerant System Tests (412-00 Climate Control System - General Information, General Procedures).

Heating and Ventilation -

Lubricants, Fluids and Sealers

Item	Specification
Sealant — Blower motor to blower motor housing	WSE-M4G323-A4

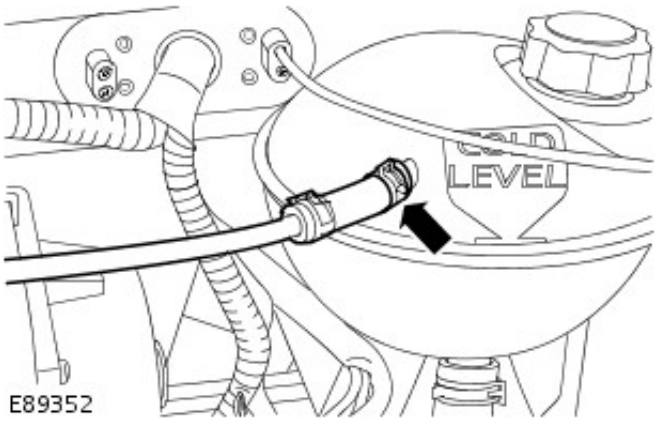
Torque specifications

Discription	Nm	lb-ft
Blower	15	11
Heater core and evaporator core housing	15	11
Heater control valve nut	6	4
Heater control valve bolt	22	16

Heating and Ventilation - Blower
Removal and Installation

Removal

1. Remove the air inlet duct.
For additional information, refer to: Air Inlet Duct (412-01 Air Distribution and Filtering, Removal and Installation).



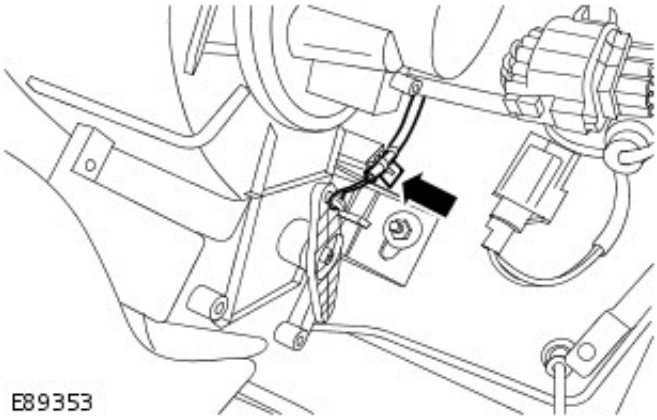
2. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the coolant expansion tank pipe.

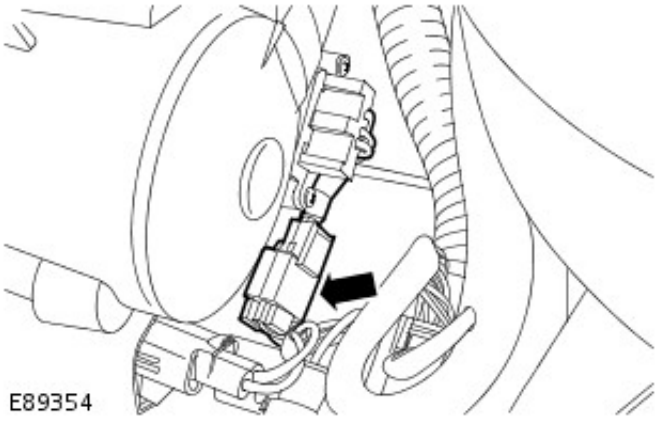
- Release the clip.

3. Disconnect the recirculation blend door control cable.

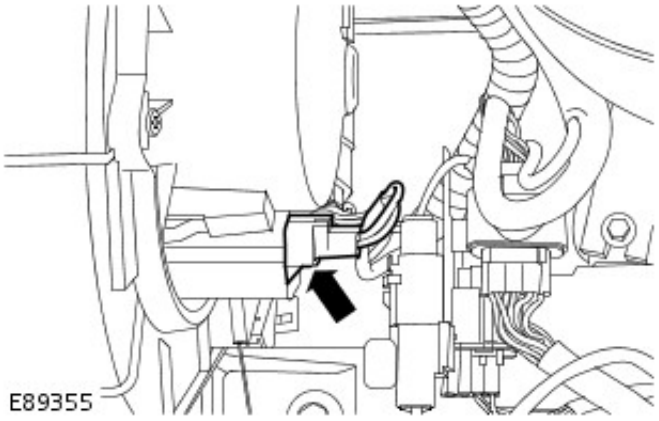
- Release the clip.



4. Disconnect the blower motor resistor electrical connector.

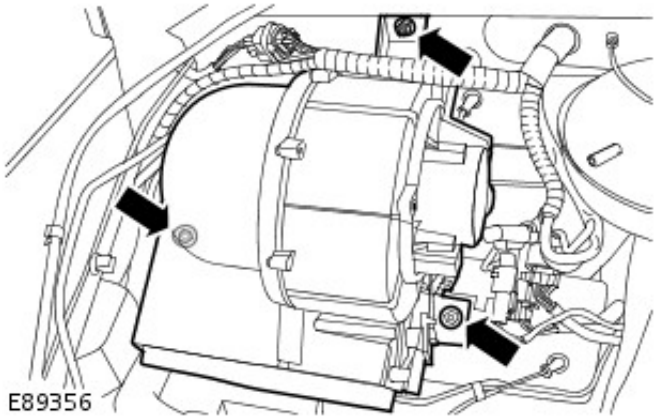


5. Disconnect the blower motor electrical connector.



6. Remove the blower.

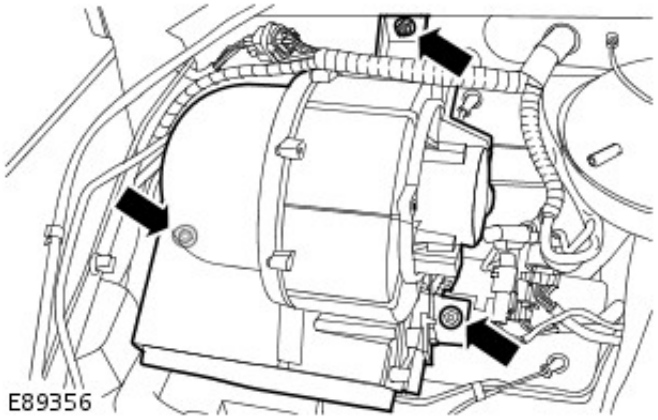
- Remove the 3 nuts.



Installation

1. To install, reverse the removal procedure.

- Tighten to 15 Nm (11 lb.ft).



Heating and Ventilation - Blower Motor

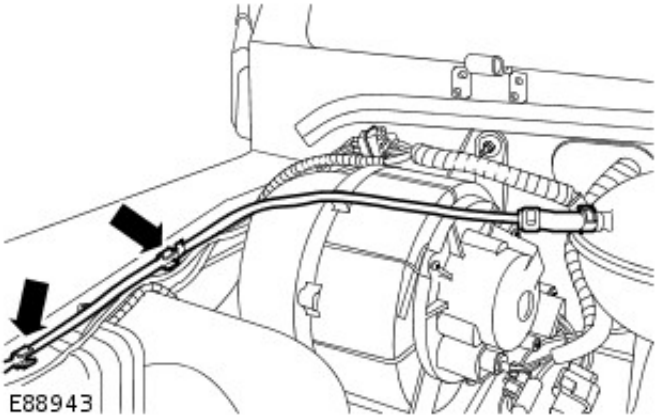
Removal and Installation

Materials

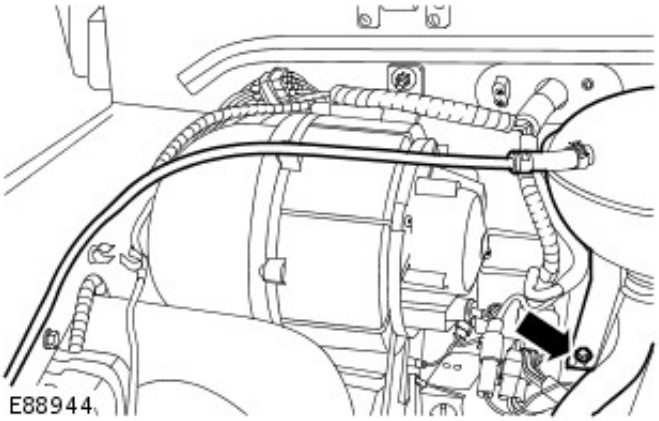
Name	Specification
Silicone Sealant	WSE-M4G323-A4

Removal

- NOTE: LHD shown, RHD similar.

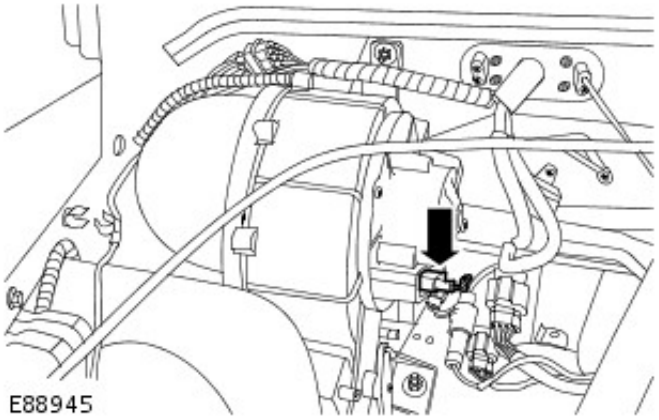


1. Release the coolant expansion tank to radiator pipe.



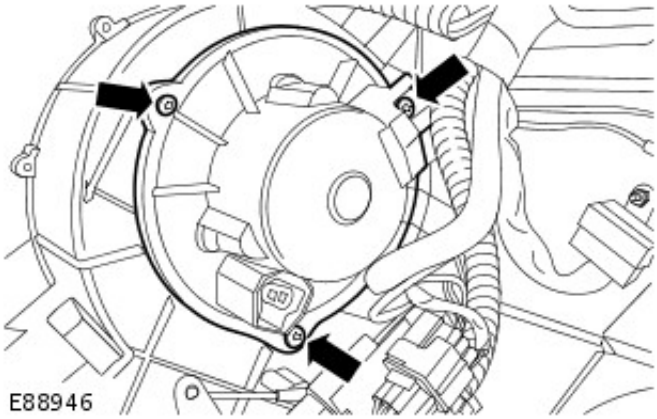
2. Release the coolant expansion tank.

- Remove the bolt.



3. Disconnect the blower motor electrical connector.

4. Remove the blower motor.



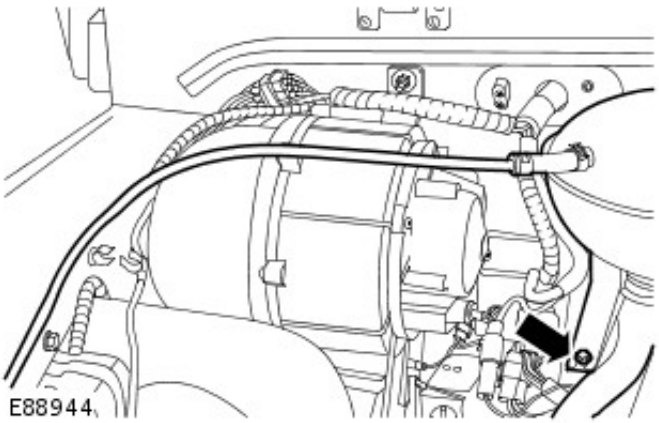
- Remove the 3 screws.

Installation

1. To install, reverse the removal procedure.

- Apply a bead of sealant to the mating faces of the blower motor and blower motor housing. sealant

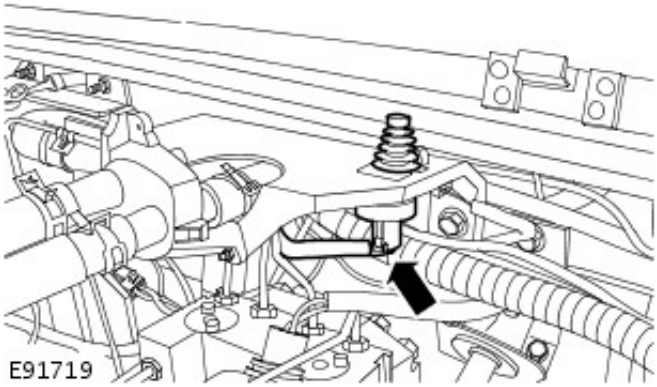
2. Tighten to 10 Nm (7 lb.ft).



Heating and Ventilation - Heater Control Valve

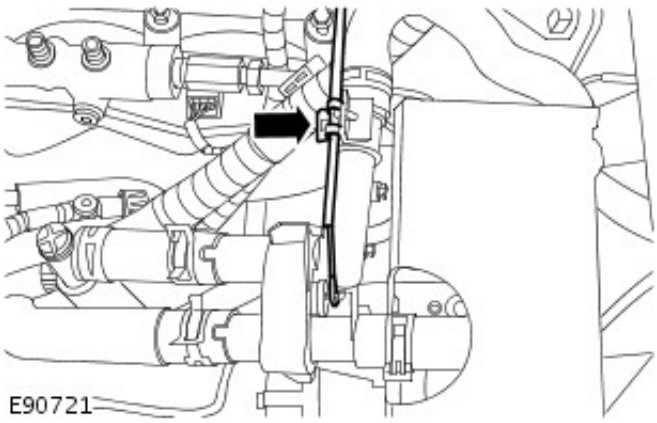
Removal and Installation

Removal



1. Remove the bonnet switch.

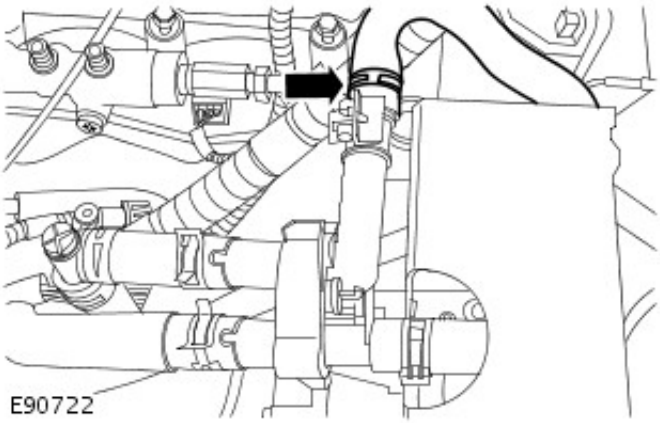
- Disconnect the bonnet switch electrical connector.



2. NOTE: Note the fitted position of the cable prior to removal.

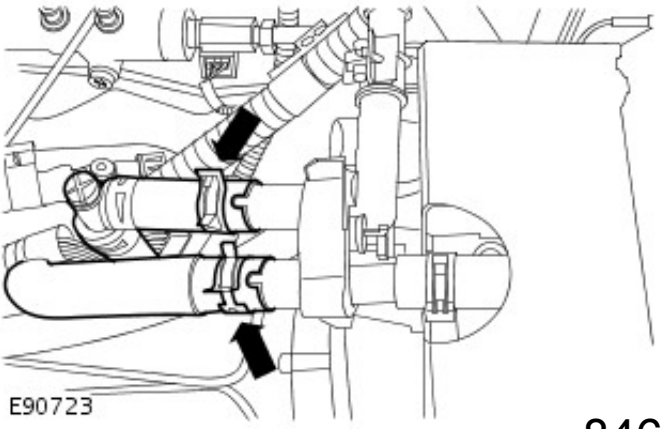
Disconnect the heater control valve control cable.

- Release the clip.



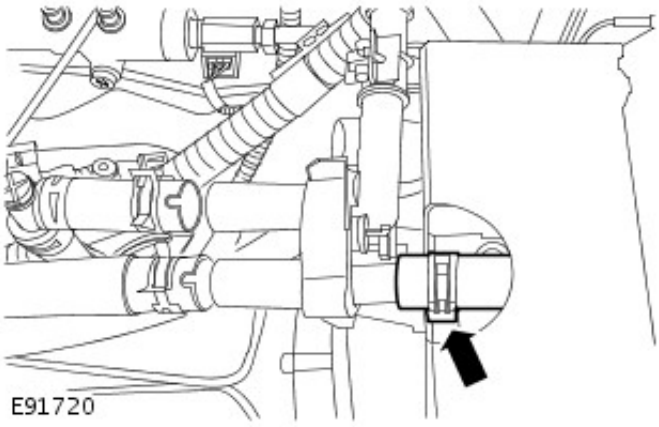
3. Disconnect the heater core feed hose.

- Using a suitable pipe clamp, clamp the hose.
- Release the clip.



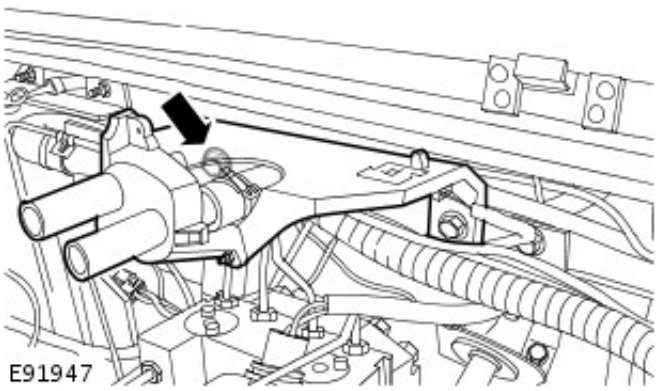
4. Disconnect the heater control valve feed and return hoses.

- Using a suitable pipe clamp, clamp the hoses.
- Release the 2 clips.



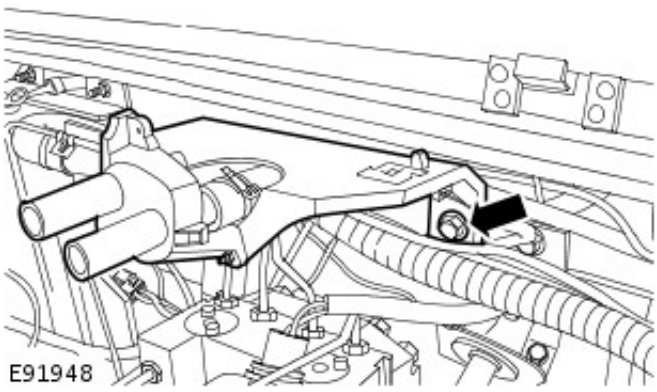
5. Disconnect the heater core return hose.

- Release the clip.



6. Release the heater control valve.

- Remove the nut.



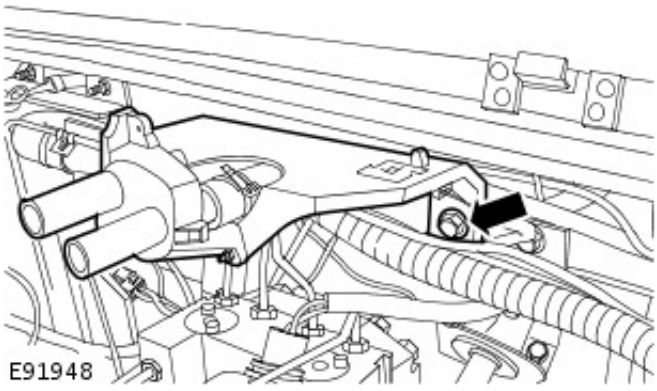
7. Remove the heater control valve.

- Remove the bolt.

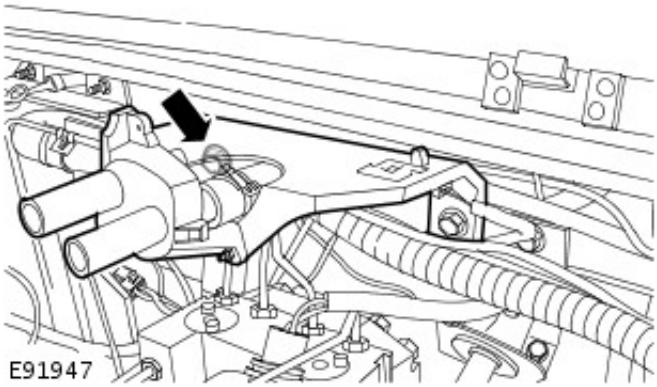
Installation

1. To install, reverse the removal procedure.

- Tighten to 22 Nm (16 lb.ft).

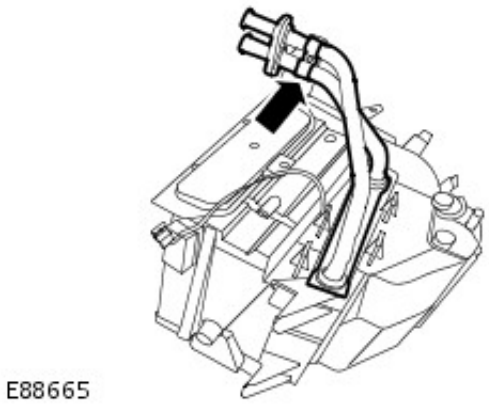


2. Tighten to 6 Nm (4 lb.ft).


E91947

Heating and Ventilation - Heater Core

Removal and Installation



Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the heater core housing.
   For additional information, refer to: Heater Core Housing (412-02 Heating and Ventilation, Removal and Installation).
3. CAUTION: Make sure no damage occurs to the foam seal on the heater core. Failure to follow this caution may result in damage to the component.

   Remove the heater core.

   - Remove the screw.
   - Remove the pipe clamp.
4. NOTE: Do not disassemble further if the component is removed for access only.

   Remove the grommet from the heater core pipes.

Installation

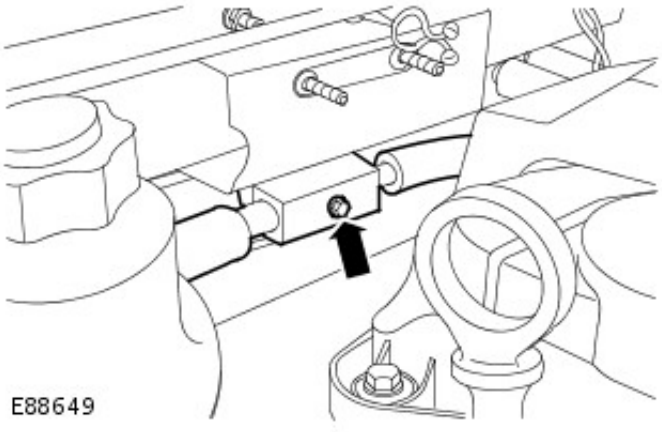
1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Heating and Ventilation - Heater Core and Evaporator Core Housing

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Recover the air conditioning (A/C) refrigerant.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
3. Remove the engine control module (ECM).
   For additional information, refer to: Engine Control Module (ECM) (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).



4. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Release the thermostatic expansion valve manifold and tube assembly.

   - Remove the bolt.
   - Remove and discard the O-ring seals.

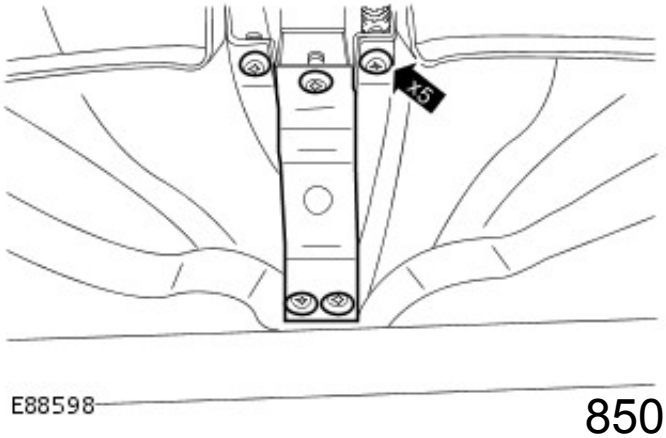
5. Disconnect the heater core hoses.
   - Using a suitable pipe clamp, clamp the heater hoses.
   - Release the 2 clips.

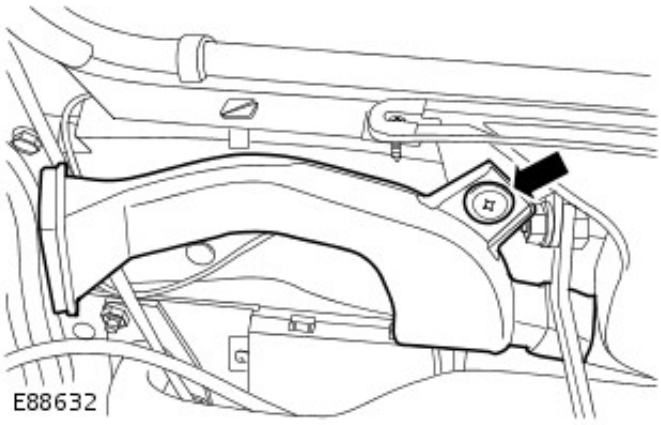
6. Remove the instrument panel.
   For additional information, refer to: Instrument Panel (501-12 Instrument Panel and Console, Removal and Installation).

7. NOTE: Make sure the clips are discarded.

   Remove the audio unit support bracket.

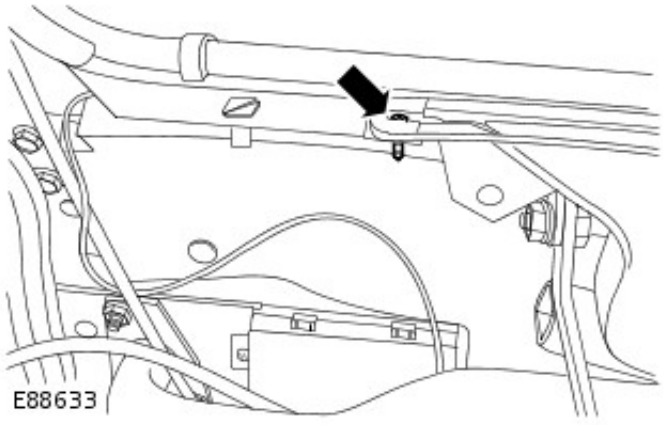
   - Remove and discard the 5 clips.





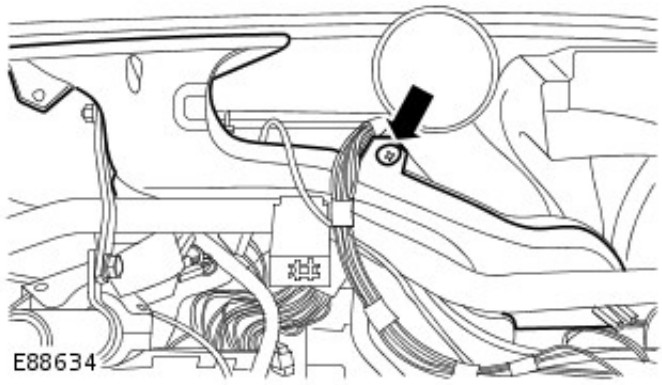
8. Remove the LH demister duct.

- Remove the clip.



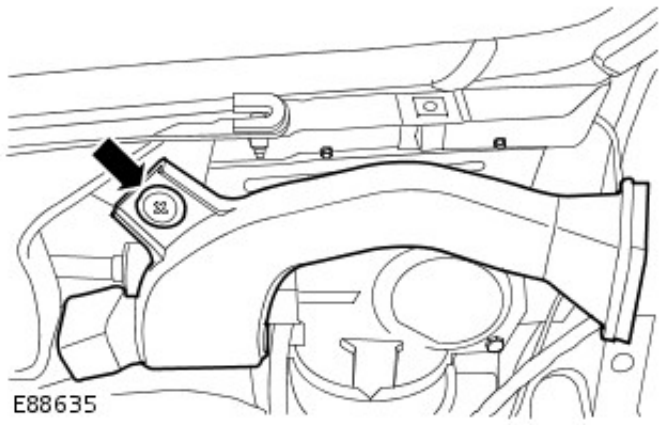
9. Release the LH defrost vent duct.

- Remove the screw.



10. Remove the LH defrost vent duct.

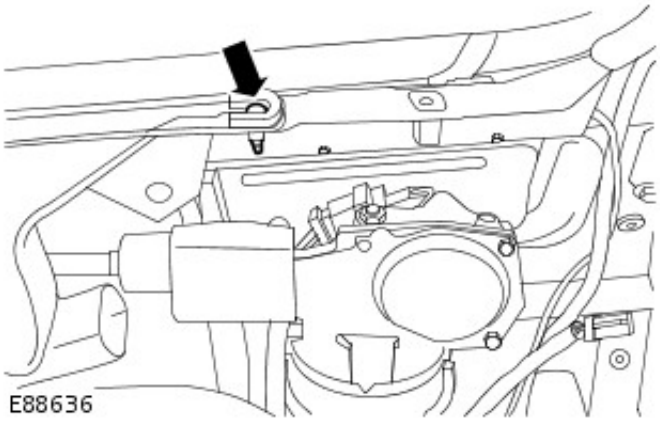
- Remove the clip.



11. Remove the RH demister duct.

- Remove the clip.

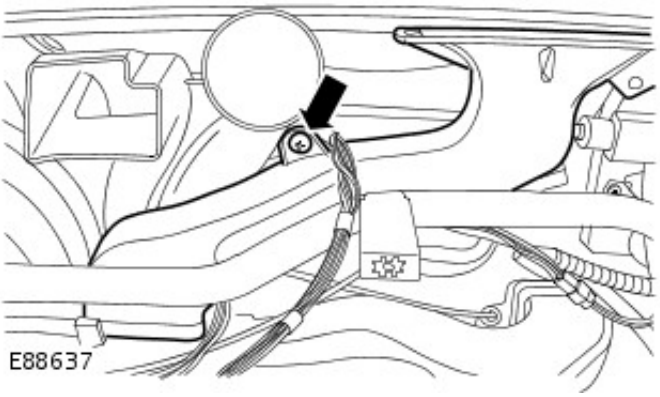
12. Release the RH defrost vent duct.



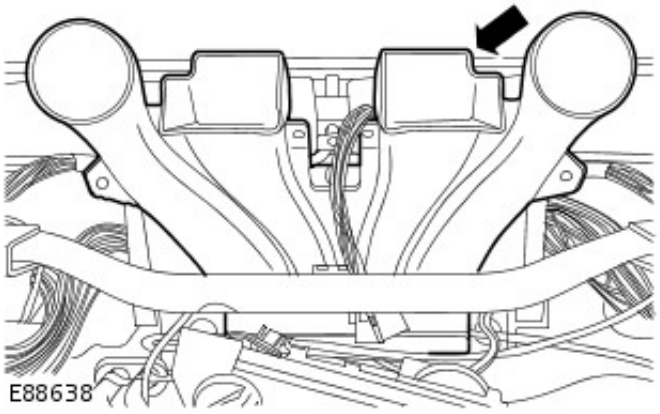
- Remove the screw.

13. Remove the RH vent duct.

- Remove the clip.

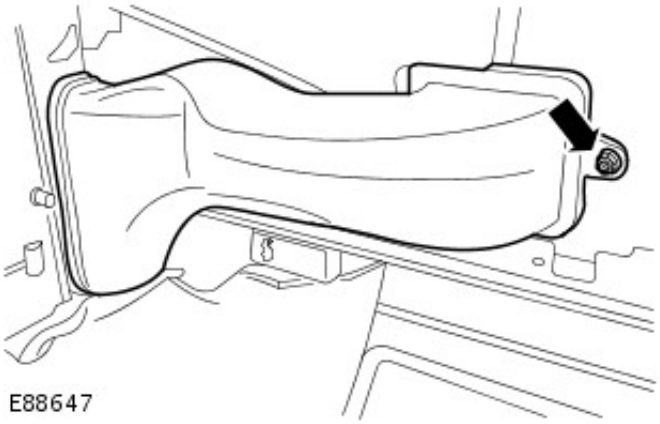


14. Remove the center register duct.



15. Remove the air inlet duct.

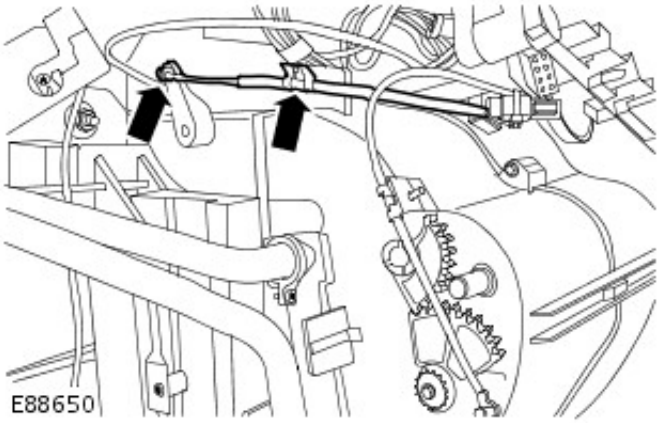
- Remove the nut.



16. Disconnect the defrost duct blend door control cable.

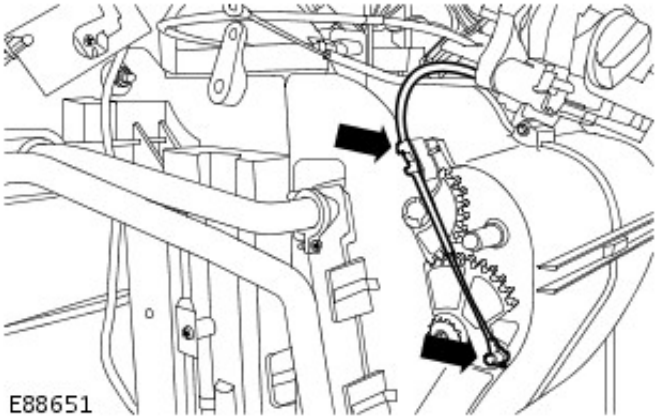
16. Disconnect the defrost duct blend door control cable.

- Release the clip.

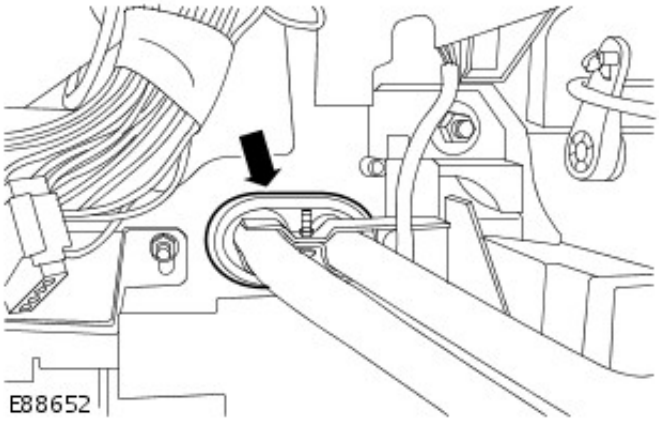


17. Disconnect the footwell duct blend door control cable.

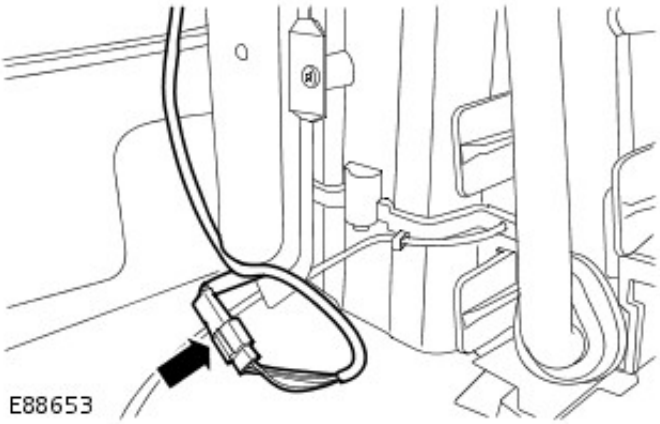
- Release the clip.



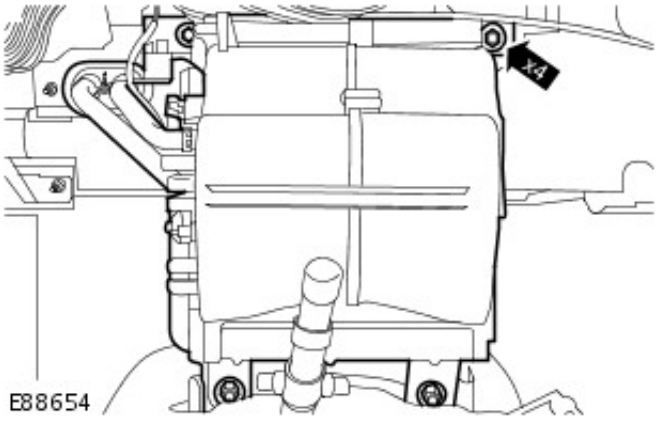
18. Release the grommet from the bulkhead.



19. Disconnect the de-icing switch electrical connector.



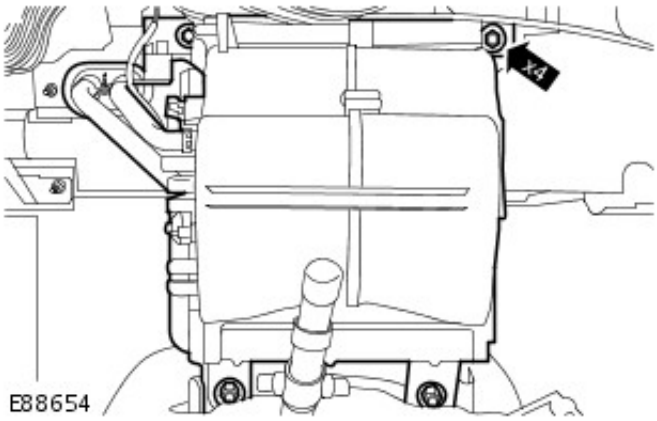
20. Remove the heater core and evaporator core housing.



- Remove the 4 nuts.

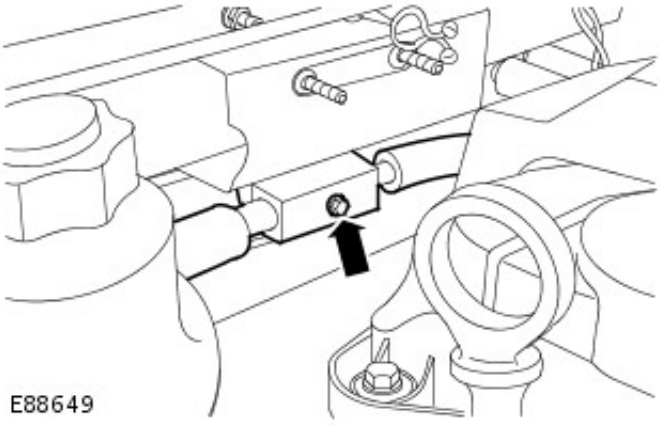
Installation

1. To install, reverse the removal procedure.



- Tighten to 15 Nm (11 lb.ft).

2. Tighten to 8 Nm (6 lb.ft).



3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Heating and Ventilation - Heater Core Housing

Removal and Installation

Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Disconnect the heater core hoses.

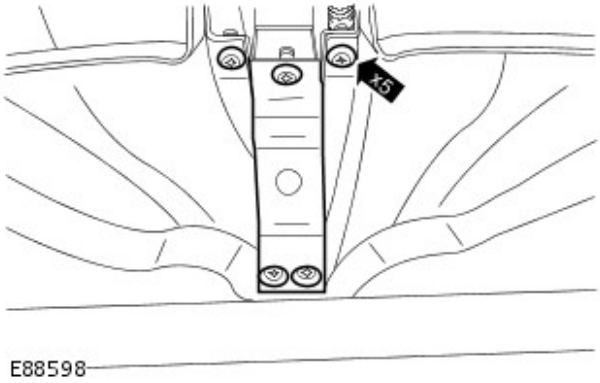
- Using a suitable pipe clamp, clamp the heater hoses.
- Release the 2 clips.

3. Remove the instrument panel.
For additional information, refer to: Instrument Panel (501-12 Instrument Panel and Console, Removal and Installation).

4. NOTE: Make sure the clips are discarded.

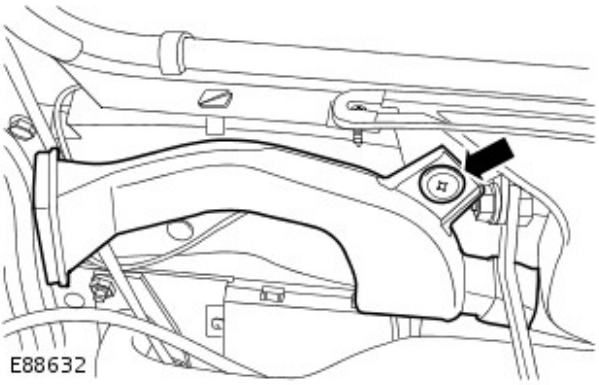
Remove the audio unit support bracket.

- Remove and discard the 5 clips.



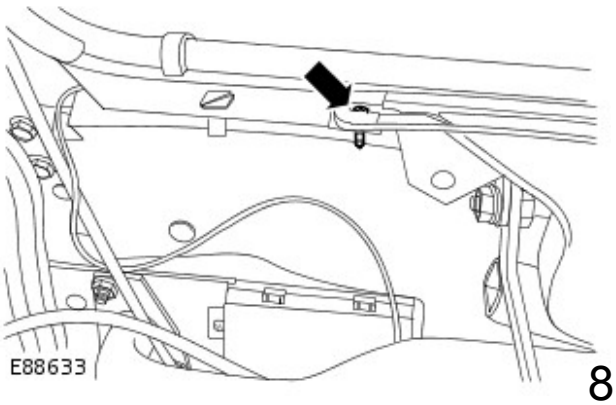
5. Remove the LH demister duct.

- Remove the clip.



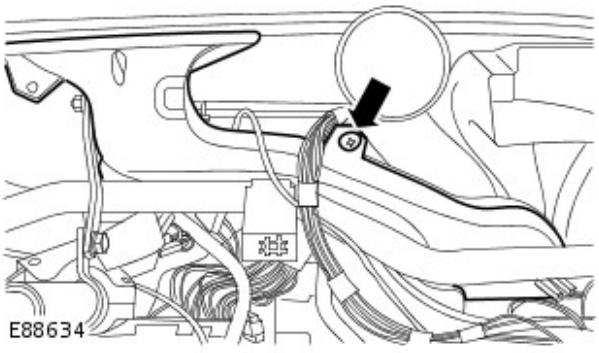
6. Release the LH defrost vent duct.

- Remove the screw.



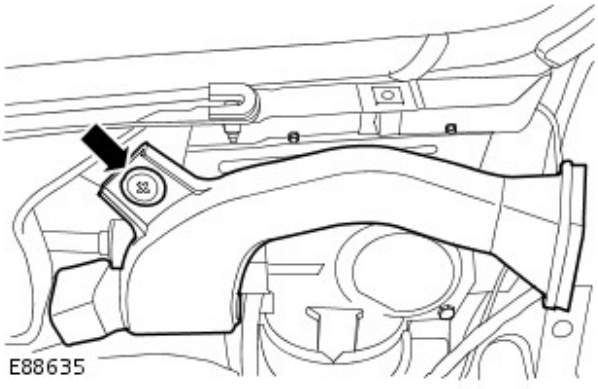
7. Remove the LH defrost vent duct.

- Remove the clip.



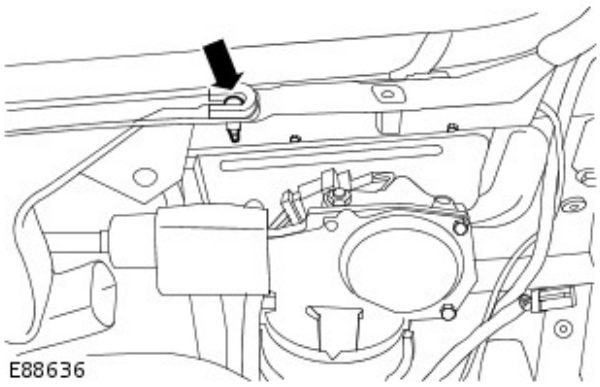
8. Remove the RH demister duct.

- Remove the clip.



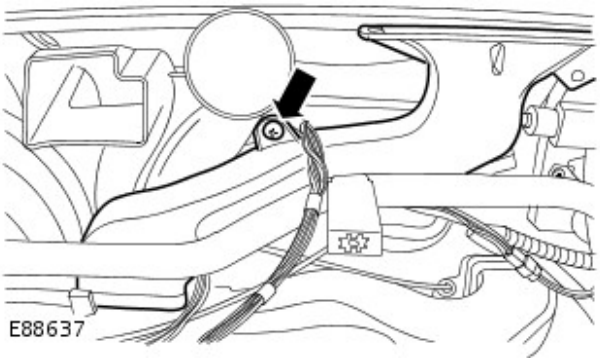
9. Release the RH defrost vent duct.

- Remove the screw.



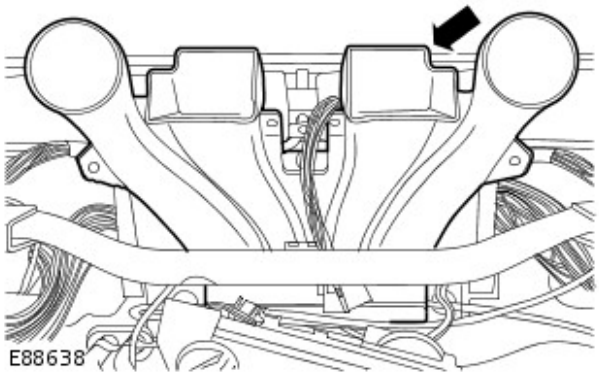
10. Remove the RH vent duct.

- Remove the clip.



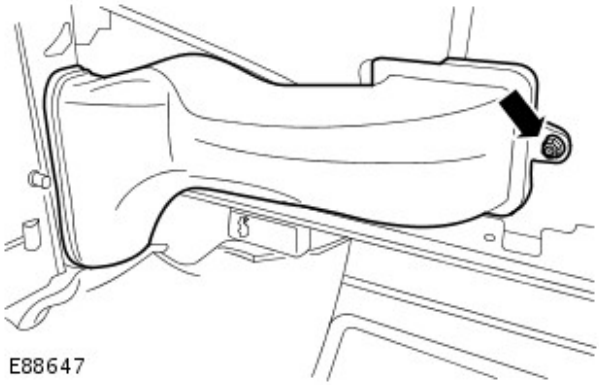
11. Remove the center register duct.

11. Remove the center register duct.



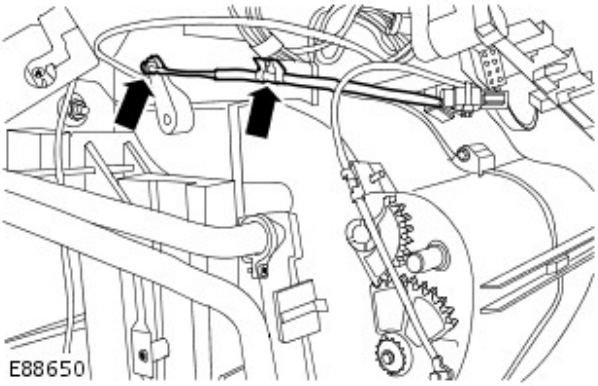
12. Remove the air inlet duct.

- Remove the nut.



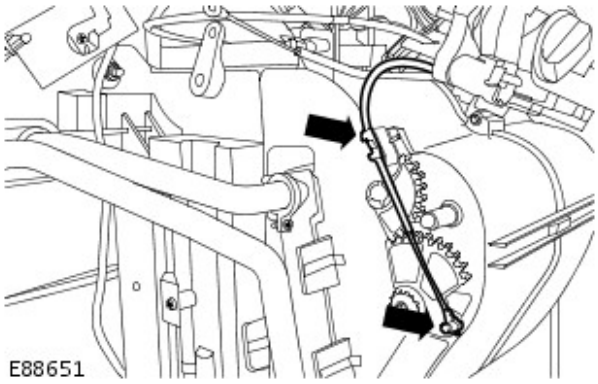
13. Disconnect the defrost duct blend door control cable.

- Release the clip.

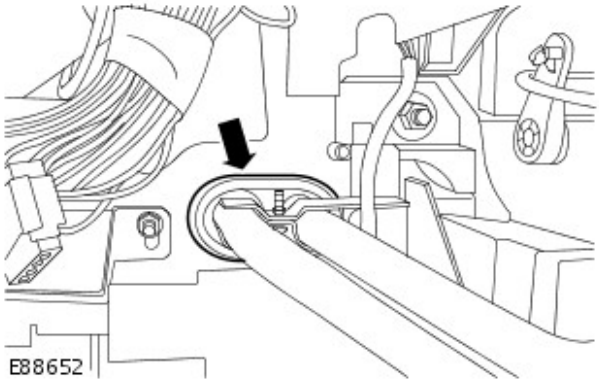


14. Disconnect the footwell duct blend door control cable.

- Release the clip.

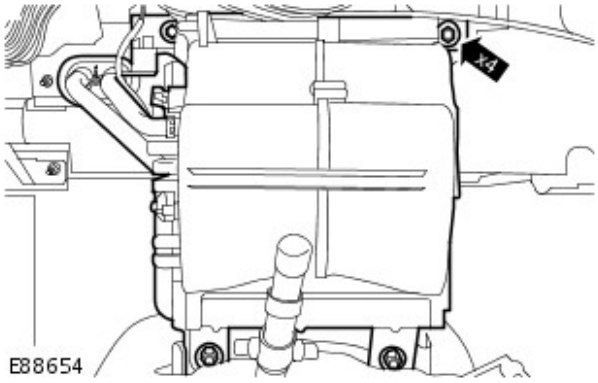


15. Release the grommet from the bulkhead.



16. Remove the heater core housing.

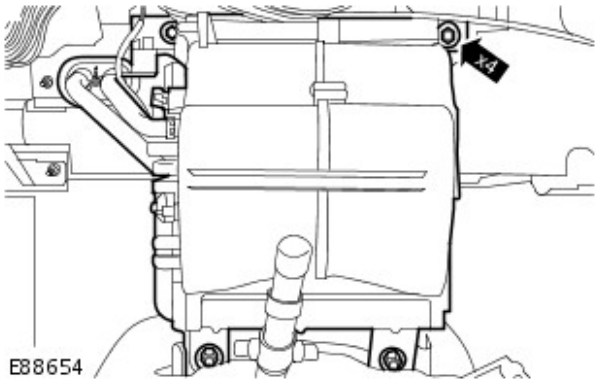
- Remove the 4 nuts.



Installation

1. To install, reverse the removal procedure.

- Tighten to 15 Nm (11 lb.ft).



2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Lubricant

Item	Specification
Compressor oil	SP-15

Lubricant

Item	Specification
Compressor oil	SP-15
Total system capacity	600g +/- 25g
Compressor	4.56 FL. OZ

System Refrigerant Specification/Capacity

Item	Specification
Refrigerant type	R134A
Total system capacity	600g +/- 25g

General Specification

Item	Description
Compressor:	
Make	Sandan
Type	SD7H15

Torque Specifications

Description	Nm	lb-ft
A/C compressor bolts	48	35
A/C compressor low-pressure and high-pressure pipe bolt	30	22
A/C condenser core low-pressure and high-pressure refrigerant lines	8	6
Condenser core and condenser fan assembly bolts	15	11
Condenser fan bolts	2	1
Condenser core nuts	8	6
A/C receiver drier nuts	8	6
A/C receiver drier low-pressure and high-pressure refrigerant line bolts	8	6
Power steering fluid reservoir nuts	4	3

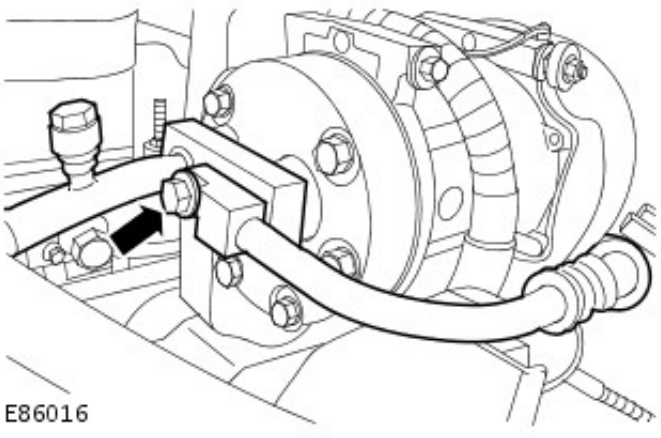
Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Air Conditioning (A/C) Compressor

Removal and Installation

Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Recover the air conditioning (A/C) refrigerant.
For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).



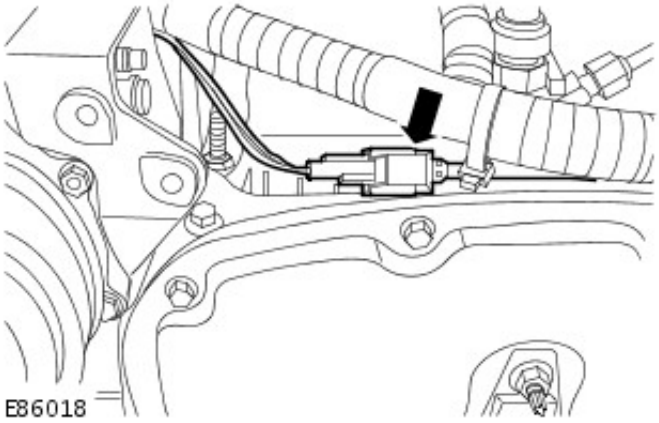
3. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the A/C compressor low-pressure and high-pressure refrigerant lines.

- Remove the bolt.
- Remove and discard the O-ring seal.

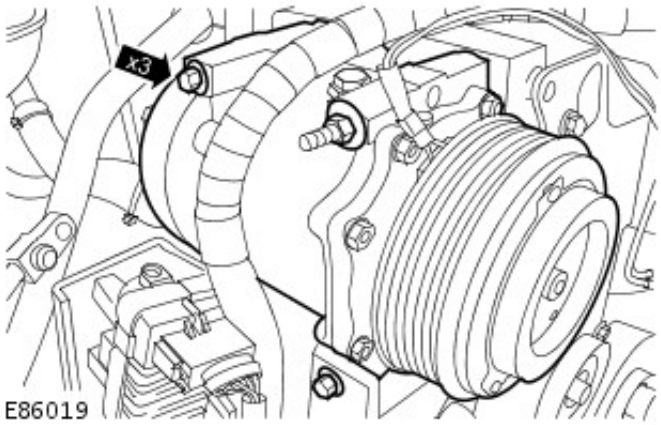
4. Remove the accessory drive belt.
For additional information, refer to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).

5. Disconnect the compressor clutch electrical connector.

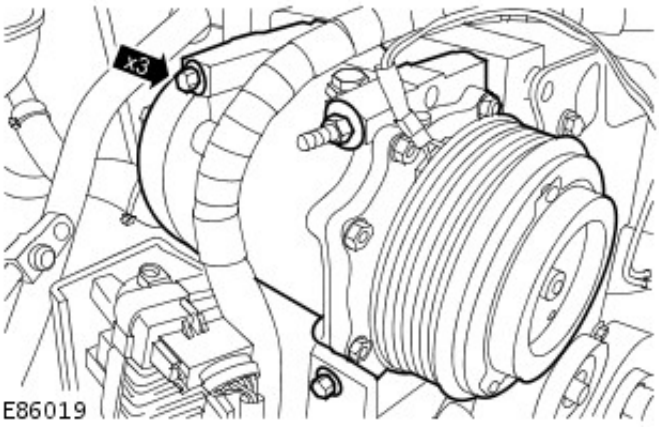


6. Remove the A/C compressor.

- Remove the 3 bolts.



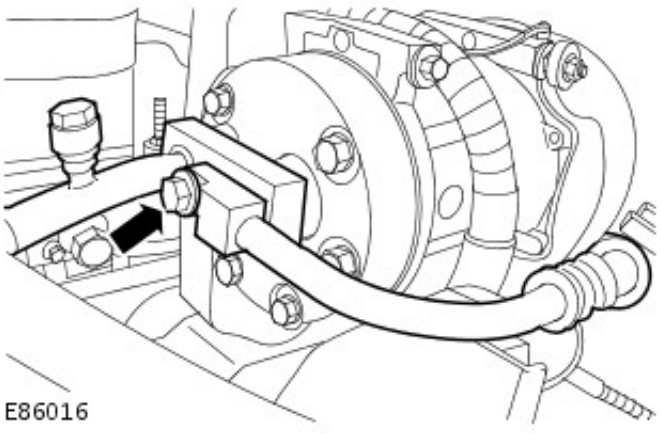
Installation



1. NOTE: If a new compressor is being installed, the required amount of refrigerant oil must be drained from it.

To install, reverse the removal procedure.

- Tighten to 23 Nm (17 lb.ft).



2. NOTE: Coat the compressor O-ring seals in clean refrigerant oil prior to installation.

• NOTE: Remove and discard the blanking caps.

Tighten to 30 Nm (22 lb.ft).

- Install new O-ring seals.

3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

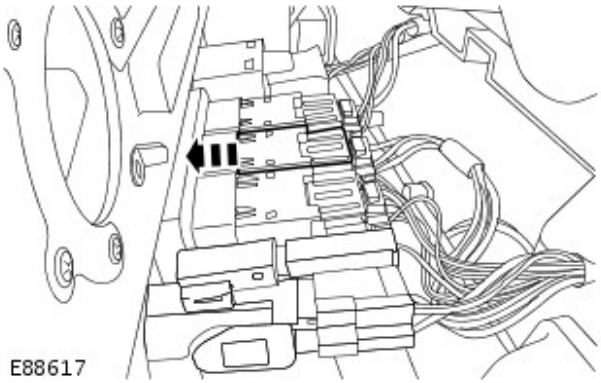
Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Air Conditioning (A/C) Switch

Removal and Installation

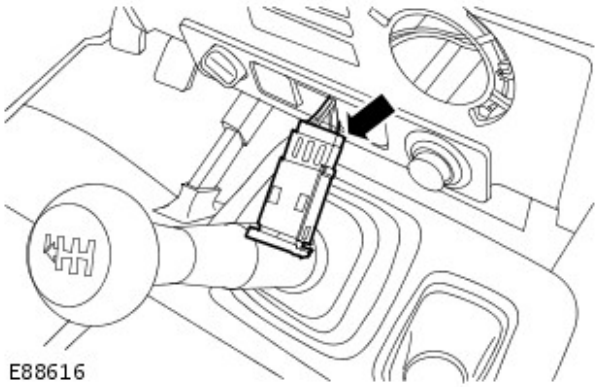
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. Release the instrument panel console.

4. Release the air conditioning (A/C) switch.



5. Remove the A/C switch.
   - Disconnect the electrical connector.



Installation

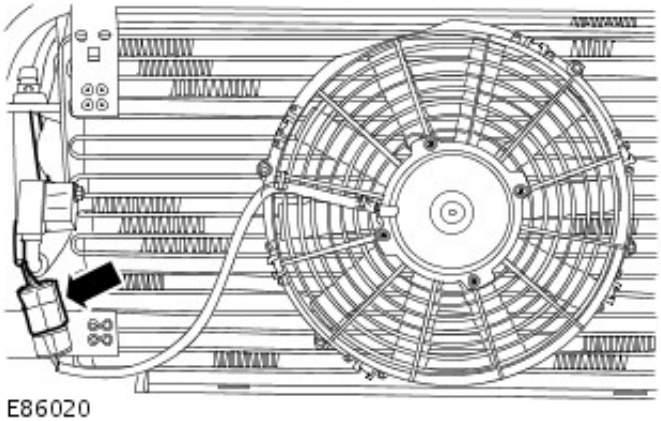
1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Condenser Core

Removal and Installation

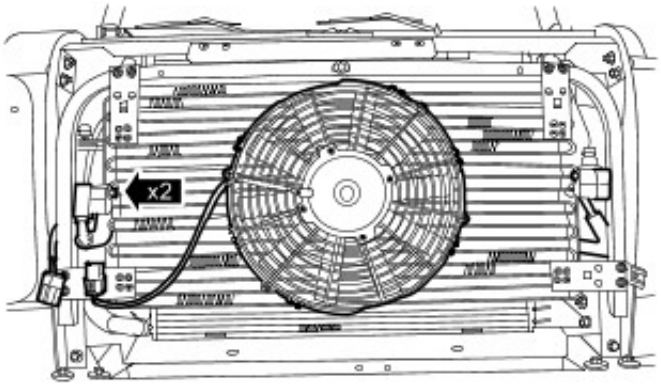
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Recover the air conditioning (A/C) refrigerant.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
3. Remove the radiator grille.
   For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).
4. Disconnect the condenser fan electrical connector.



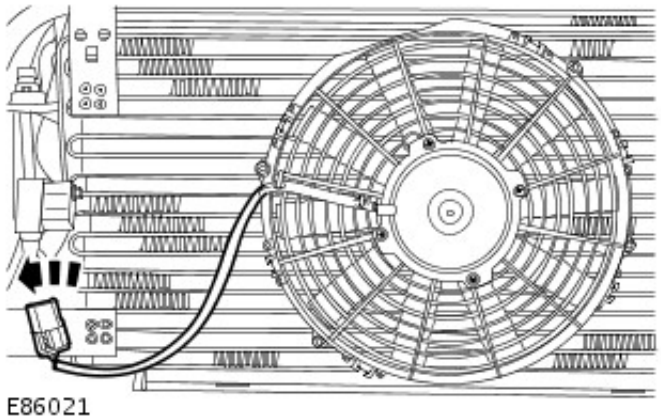
E86020

5. Disconnect the A/C condenser core low-pressure and high-pressure refrigerant lines.
   - Remove the 2 bolts.
   - Remove and discard the O-ring seals.



E86024

6. Release the condenser fan electrical connector.

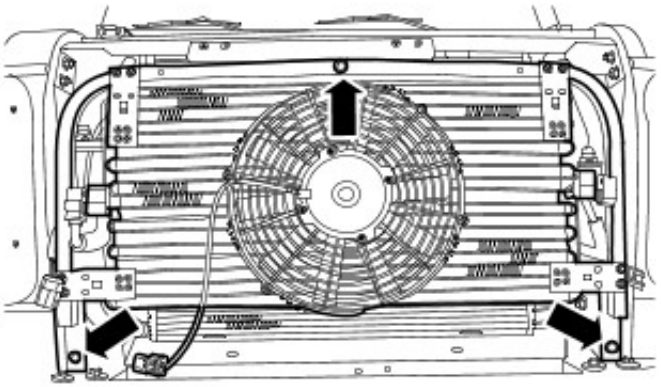


E86021

7. Remove the condenser core and condenser fan assembly.

7. Remove the condenser core and condenser fan assembly.

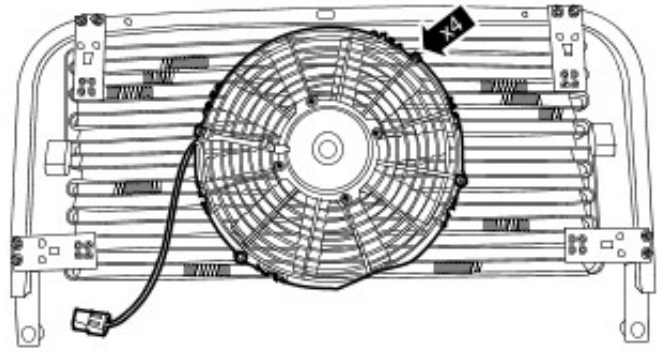
- Remove the 3 bolts.



E86025

8. Remove the condenser fan.

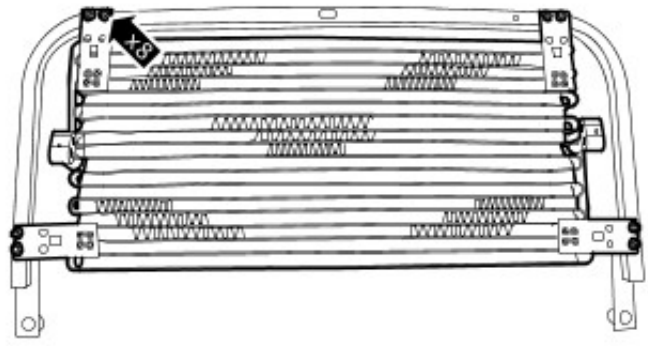
- Remove the 4 bolts.



E86026

9. Remove the condenser core.

- Remove the 8 nuts.

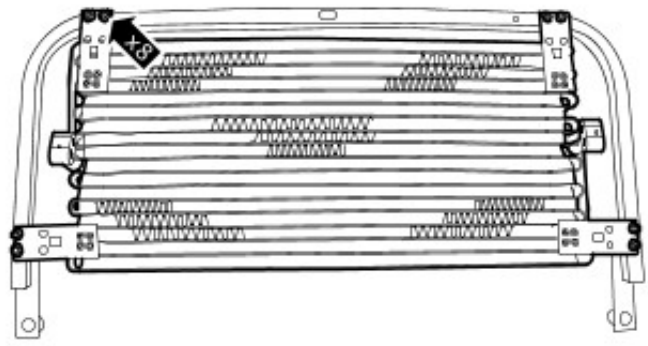


E86027

Installation

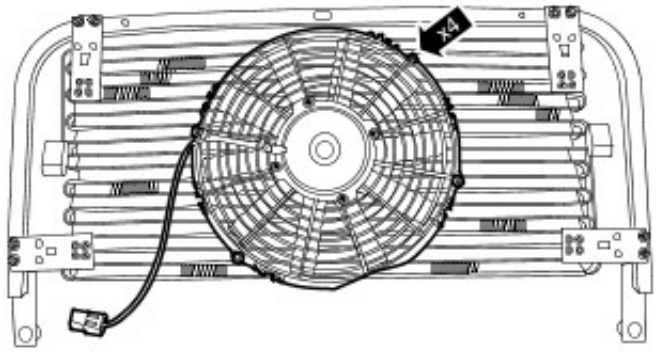
1. To install, reverse the removal procedure.

- Tighten to 8 Nm (6 lb.ft).



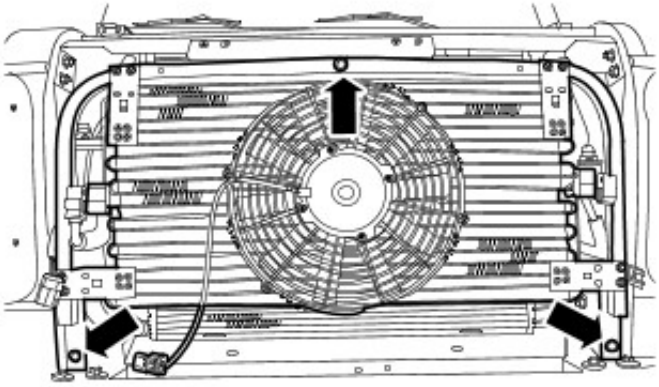
E86027

2. Tighten to 2 Nm (1 lb.ft).



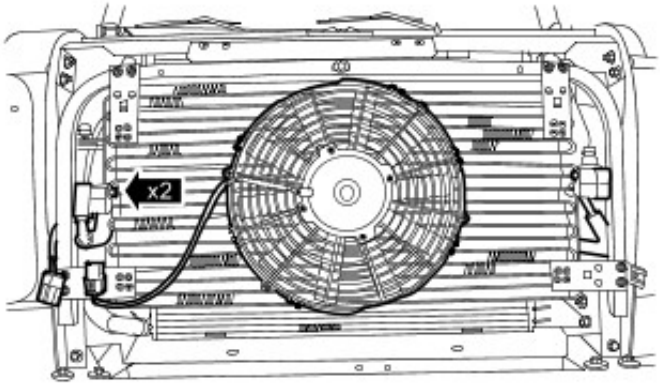
E86026

3. Tighten to 15 Nm (11 lb.ft).



E86025

4. Tighten to 8 Nm (6 lb.ft).



E86024

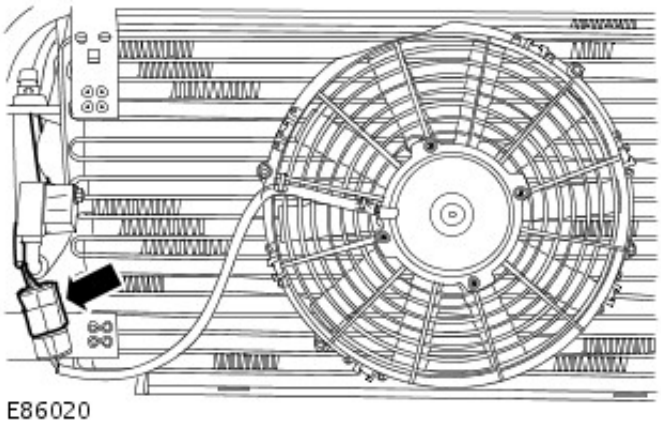
5. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Condenser Fan

Removal and Installation

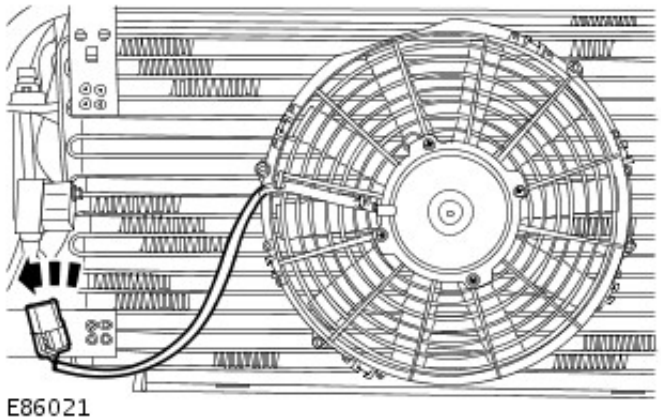
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the radiator grille.
   For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).
3. Disconnect the condenser fan electrical connector.



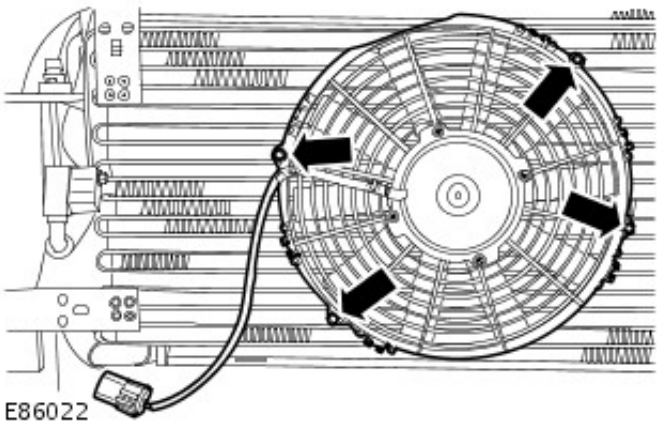
E86020

4. Release the condenser fan electrical connector.



E86021

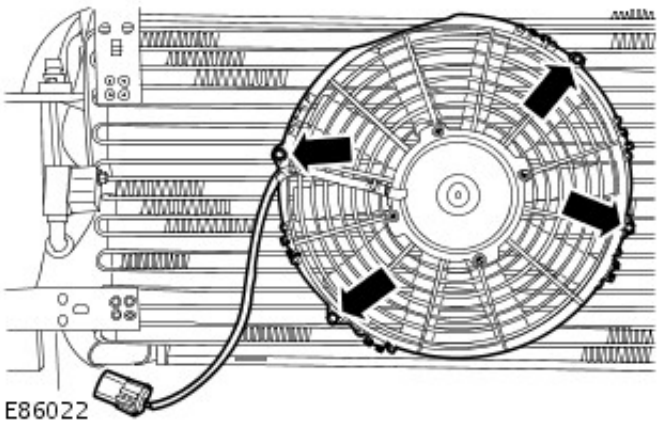
5. Remove the condenser fan.
   - Remove the 4 bolts.



E86022

Installation

1. To install, reverse the removal procedure.

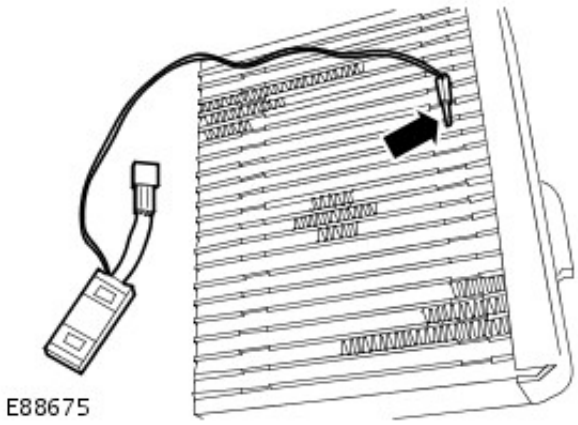


- Tighten to 2 Nm (1 lb.ft).

2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - De-Icing Switch

Removal and Installation



Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the evaporator core.
   For additional information, refer to: Evaporator Core (412-03 Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Remove the de-icing switch from the evaporator core.

Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Evaporator Core

Removal and Installation

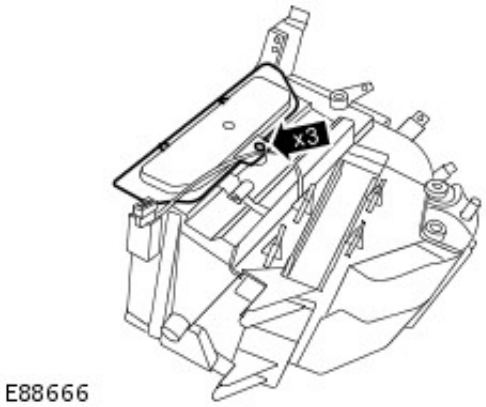
Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

2. Remove the heater core.
For additional information, refer to: Heater Core (412-02 Heating and Ventilation, Removal and Installation).

3. Remove the evaporator core end cover.

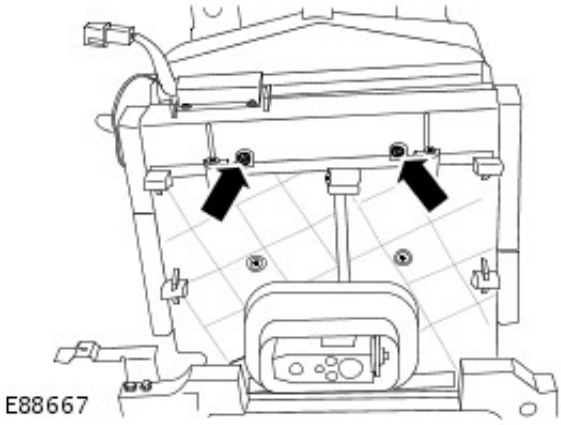
- Remove the 3 screws.



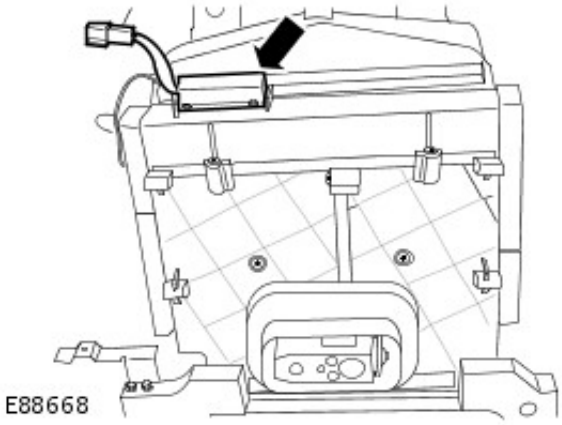
E88666

4. Release the evaporator core housing lower cover.

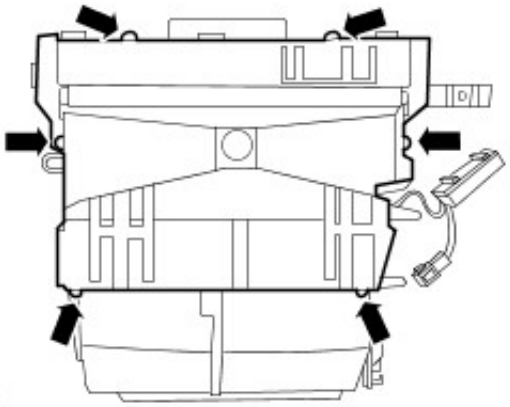
- Remove the 2 screws.


E88667

5. Release the de-icing sensor.

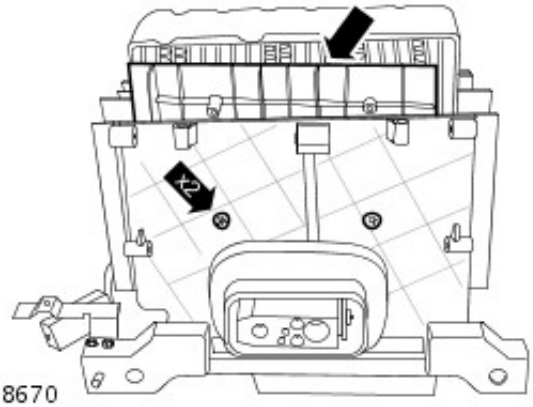

E88668

6. Remove the evaporator core housing lower cover.


E88669

- Remove the 6 screws.

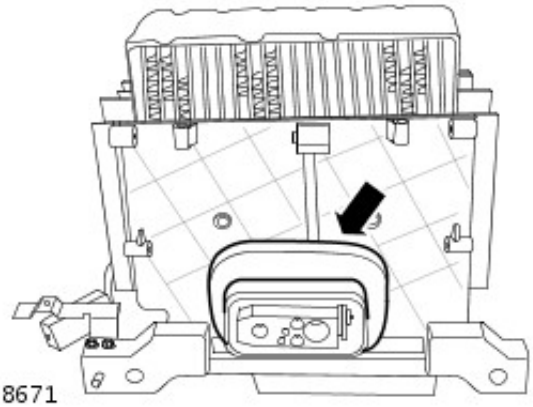
7. Remove the air flow deflector.



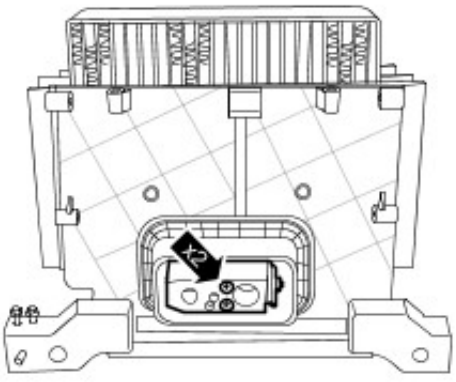
E88670

- Remove the 2 screws.

8. Remove the foam seal.


E88671

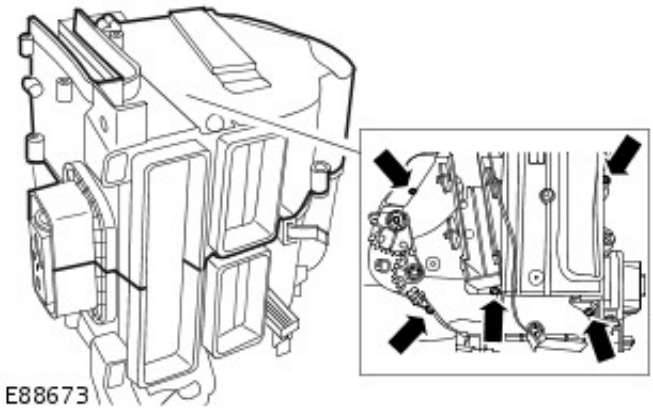
9. Remove the thermostatic expansion valve.



E88672

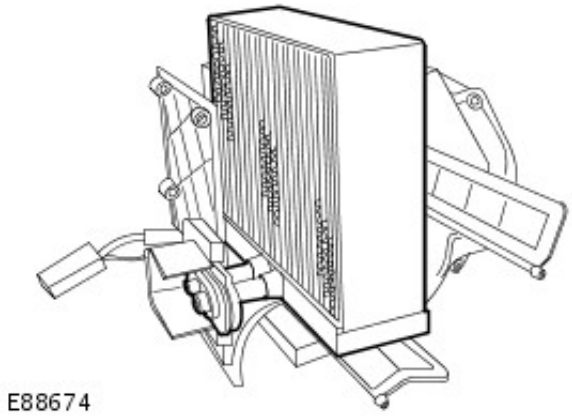
- Remove the 2 bolts.
- Remove and discard the O-ring seals.

10. Seperate the evaporator core housing.

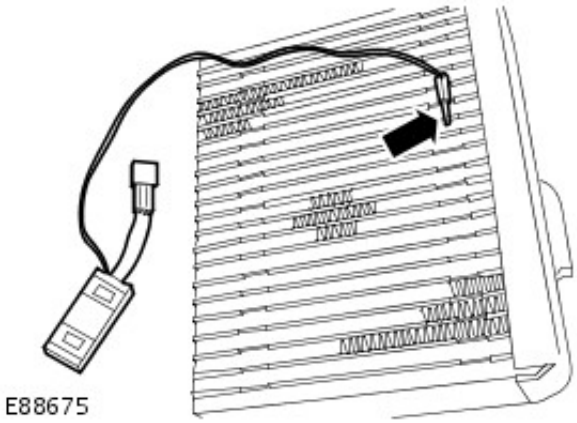

E88673

- Remove the 5 screws.

11. Remove the evaporator core.


E88674

12. Remove the de-icing switch from the evaporator core.


E88675

Installation

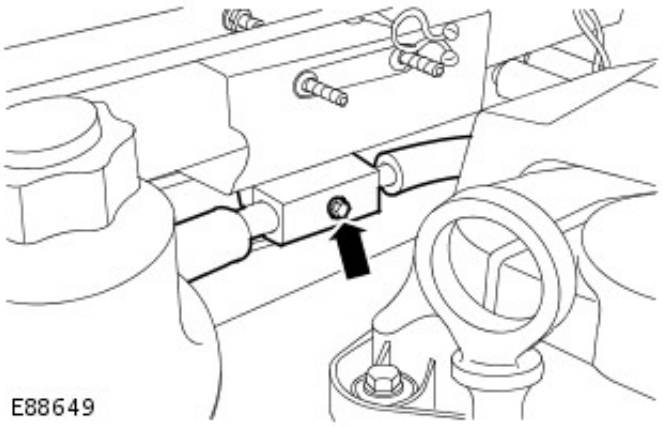
1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Thermostatic Expansion Valve

Removal and Installation

Removal

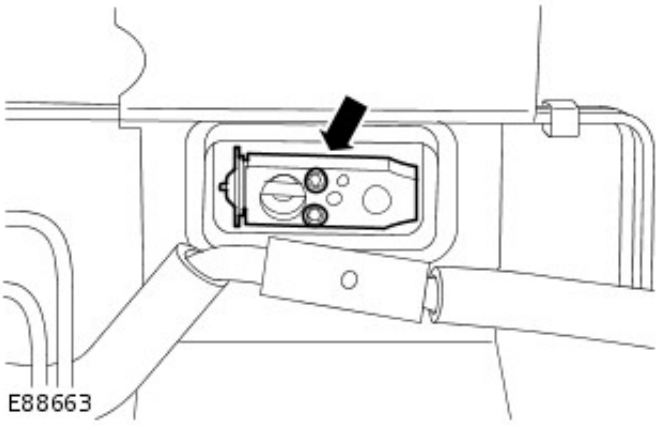
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Recover the air conditioning (A/C) refrigerant.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
3. Remove the engine control module (ECM).
   For additional information, refer to: Engine Control Module (ECM) (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).



4. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

   Release the thermostatic expansion valve manifold and tube assembly.

   - Remove the bolt.
   - Remove and discard the O-ring seal.



5. Remove the thermostatic expansion valve.
   - Remove the 2 bolts.
   - Remove and discard the O-ring seals.

Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Receiver Drier

Removal and Installation

Removal

1. Recover the air conditioning (A/C) refrigerant.
For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

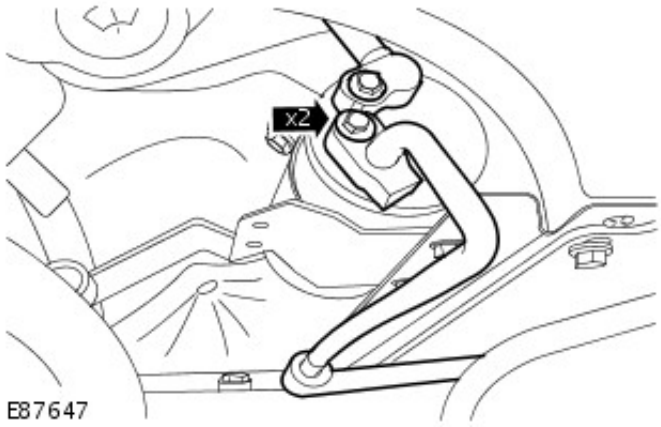
2. Release the power steering fluid reservoir.

- Remove the 2 nuts.

3. CAUTION: Make sure that all openings are sealed. Use new blanking caps.

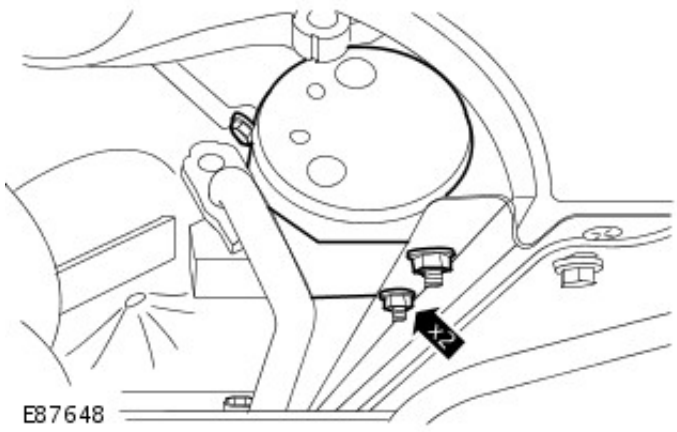
Disconnect the A/C receiver drier low-pressure and high-pressure refrigerant lines.

- Remove the 2 bolts.
- Remove and discard the O-ring seals.



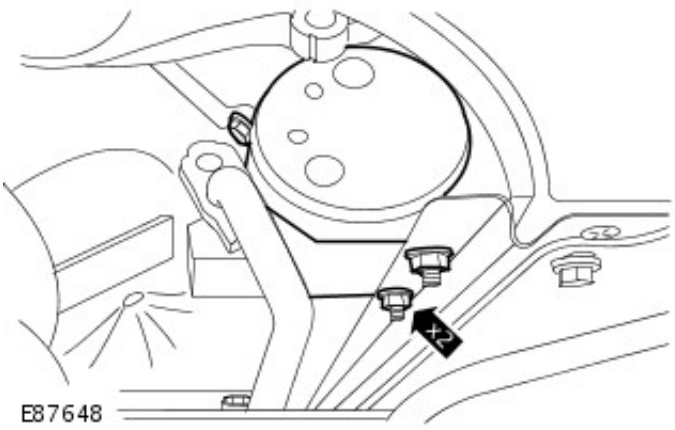
4. Remove the A/C receiver drier.

- Remove the 2 nuts.



Installation

1. Install the A/C receiver drier.



- Tighten to 8 Nm (6 lb.ft).

2. NOTE: Coat the receiver drier O-ring seals in clean refrigerant oil prior to installation.

• NOTE: Remove and discard the blanking caps.

Connect the A/C receiver drier low-pressure and high-pressure refrigerant lines.

- Tighten to 8 Nm (6 lb.ft).

3. Secure the power steering fluid reservoir.

- Tighten to 4 Nm (3 lb.ft).

4. Refill the air conditioning (A/C) refrigerant.
For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).

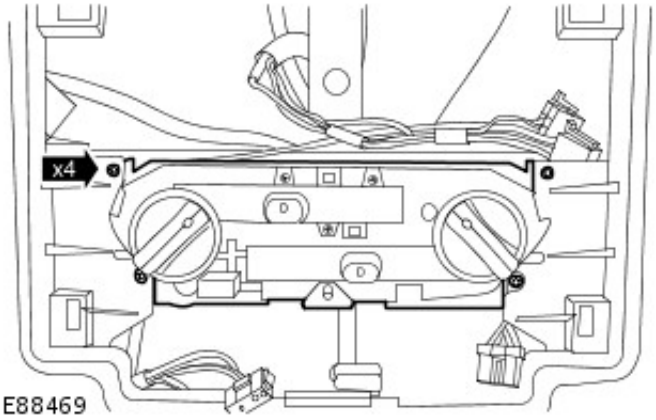
Control Components - Climate Control Assembly
Removal and Installation

Removal

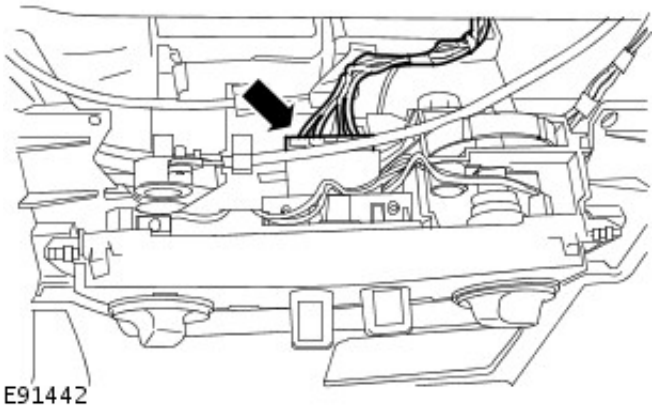
1. Remove the instrument panel console.
For additional information, refer to: Instrument Panel Console (501-12 Instrument Panel and Console, Removal and Installation).

2. Release the climate control assembly.

- Remove the 4 screws.

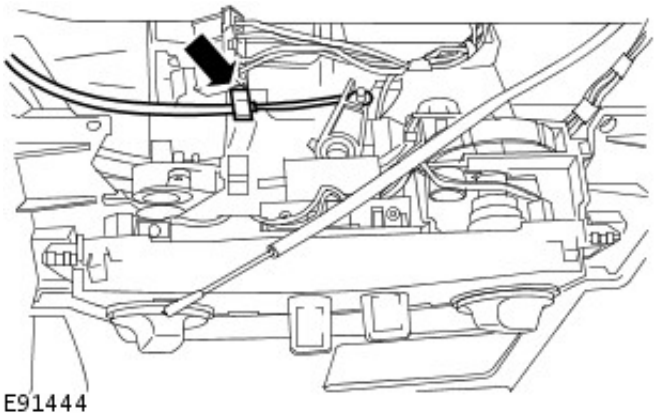


3. Disconnect the blower motor speed control switch electrical connector.

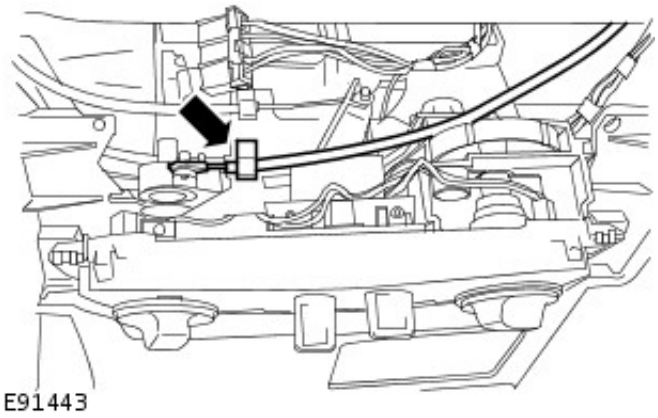


4. Disconnect the recirculation blend door control cable.

- Release the clip.

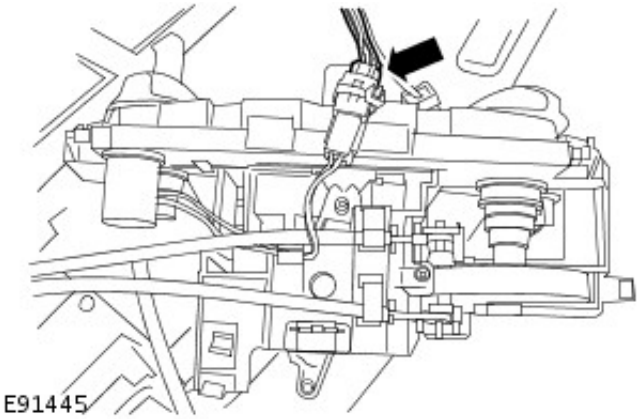


5. Disconnect the heater control valve control cable.

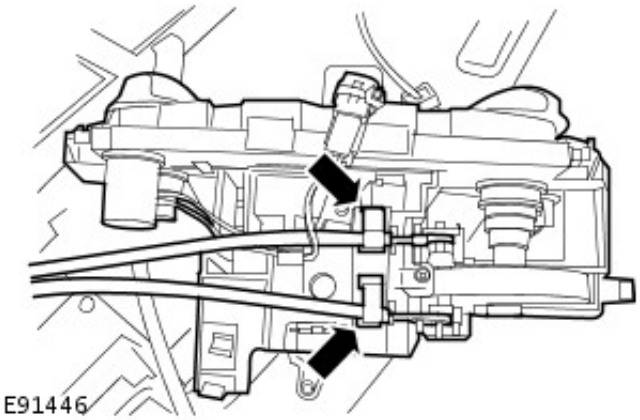

E91443

5. Disconnect the heater control valve control cable.

- Release the clip.


E91445

6. Disconnect the climate control assembly illumination electrical connector.


E91446

7. Remove the climate control assembly.

- Release the clips.
- Disconnect the 2 blend door control cables.

Installation

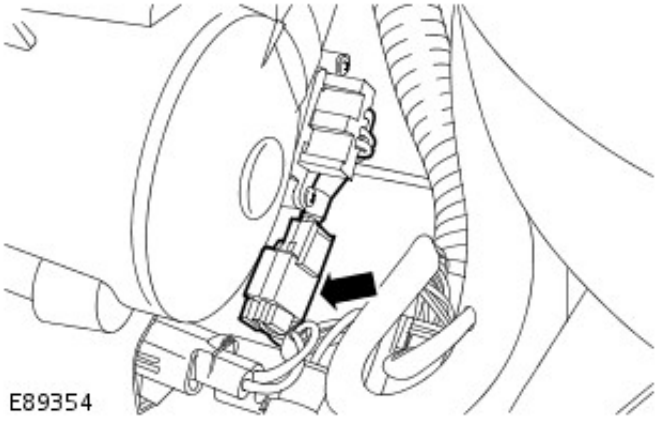
1. To install, reverse the removal procedure.

Control Components - Blower Motor Resistor

Removal and Installation

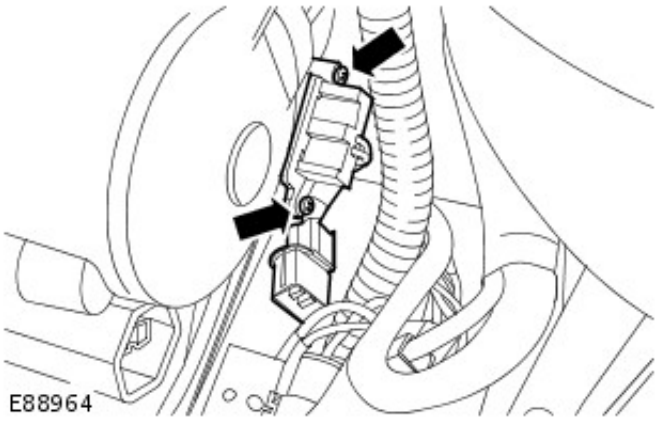
Removal

1. Disconnect the electrical connector.



2. Remove the blower motor resistor.

- Remove the 2 screws.



Installation

1. To install, reverse the removal procedure.

Instrument Cluster -

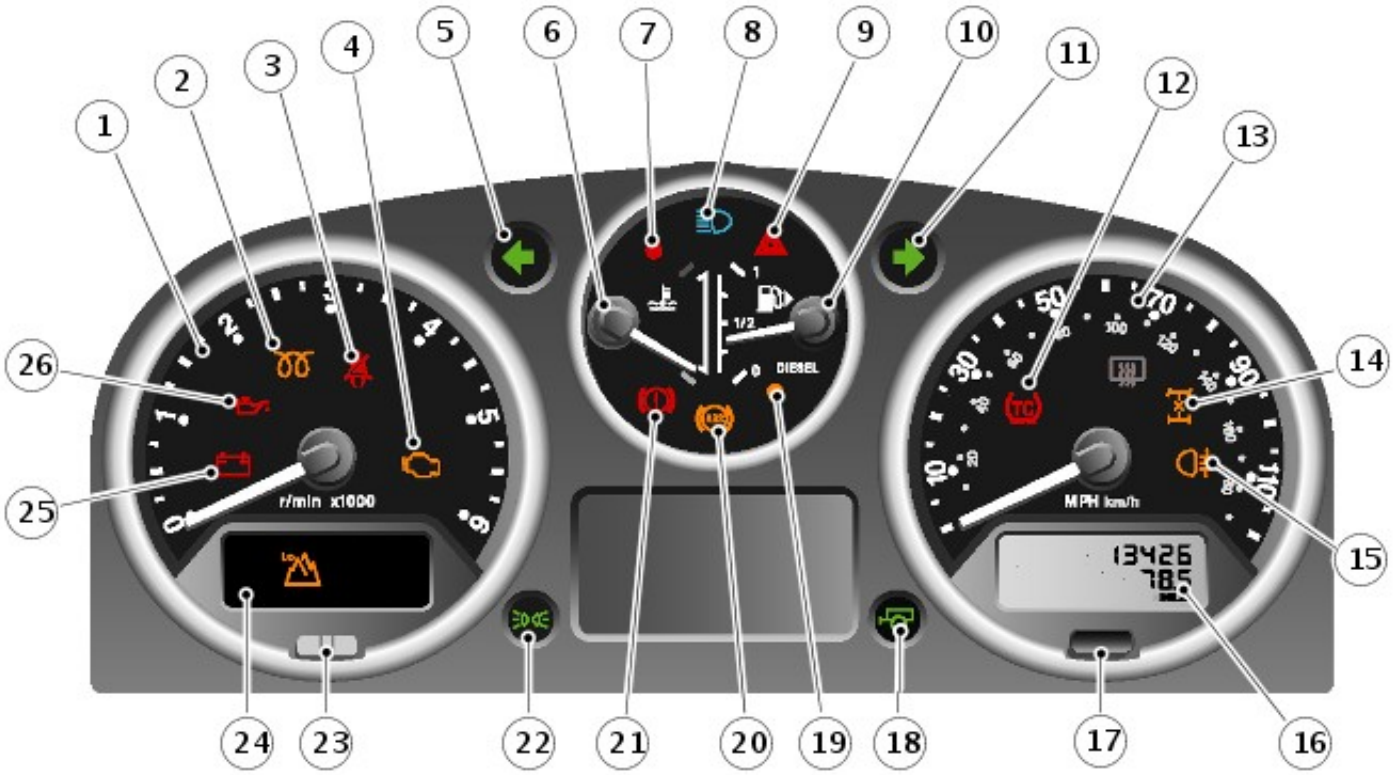
Torque specifications

Discription	Nm	lb.ft
Instrument cluster	2	1
Instrument cluster upper finisher	2	1
Instrument cluster lower finisher	2	1

Instrument Cluster - Instrument Cluster

Description and Operation

COMPONENT LOCATION



E83308

Item	Part Number	Description
1	-	Tachometer
2	-	Glow plugs active indicator
3	-	Safety belt indicator (Gulf States only)
4	-	malfunction indicator lamp (MIL)
5	-	Left turn signal indicator
6	-	engine coolant temperature (ECT) gauge
7	-	High ECT indicator
8	-	High beam indicator
9	-	Hazard flasher indicator
10	-	Fuel level gauge
11	-	Right turn signal indicator
12	-	Traction control indicator
13	-	Speedometer
14	-	Differential lock indicator
15	-	Rear fog lamp indicator
16	-	Odometer and trip meter display
17	-	Trip reset button
18	-	Trailer indicator
19	-	Low fuel indicator
20	-	anti-lock brake system (ABS) indicator
21	-	Brake warning indicator
22	-	Side lamps on indicator
23	-	Anti-theft alarm indicator
24	-	Transfer box low range indicator
25	-	Ignition/No charge indicator
26	-	Low oil pressure indicator

OVERVIEW

The instrument cluster is located in the instrument panel, above the steering column. The instrument cluster comprises analogue gauges and a number of indicator lamps to display system status.

ANALOGUE GAUGES

The analogue gauges located in the instrument cluster are as follows:

- Speedometer
- Tachometer
- Fuel level gauge
- ECT gauge.

Each analogue gauge is driven by an electronic stepper motor. The characteristics of this type of motor produce damping of the pointer needle. All gauges return to their respective zero positions when the ignition is switched off.

INDICATOR LAMPS

Indicator lamps are located in various positions in the instrument cluster and can be split into 2 groups; self controlled and externally controlled.

Self controlled indicators are dependent on software logic within the instrument cluster for activation.

Externally controlled indicators are supplied with current from their respective systems. Engine related externally controlled indicators are illuminated by the instrument cluster on receipt of a high speed controller area network (CAN) bus message from the engine control module (ECM).

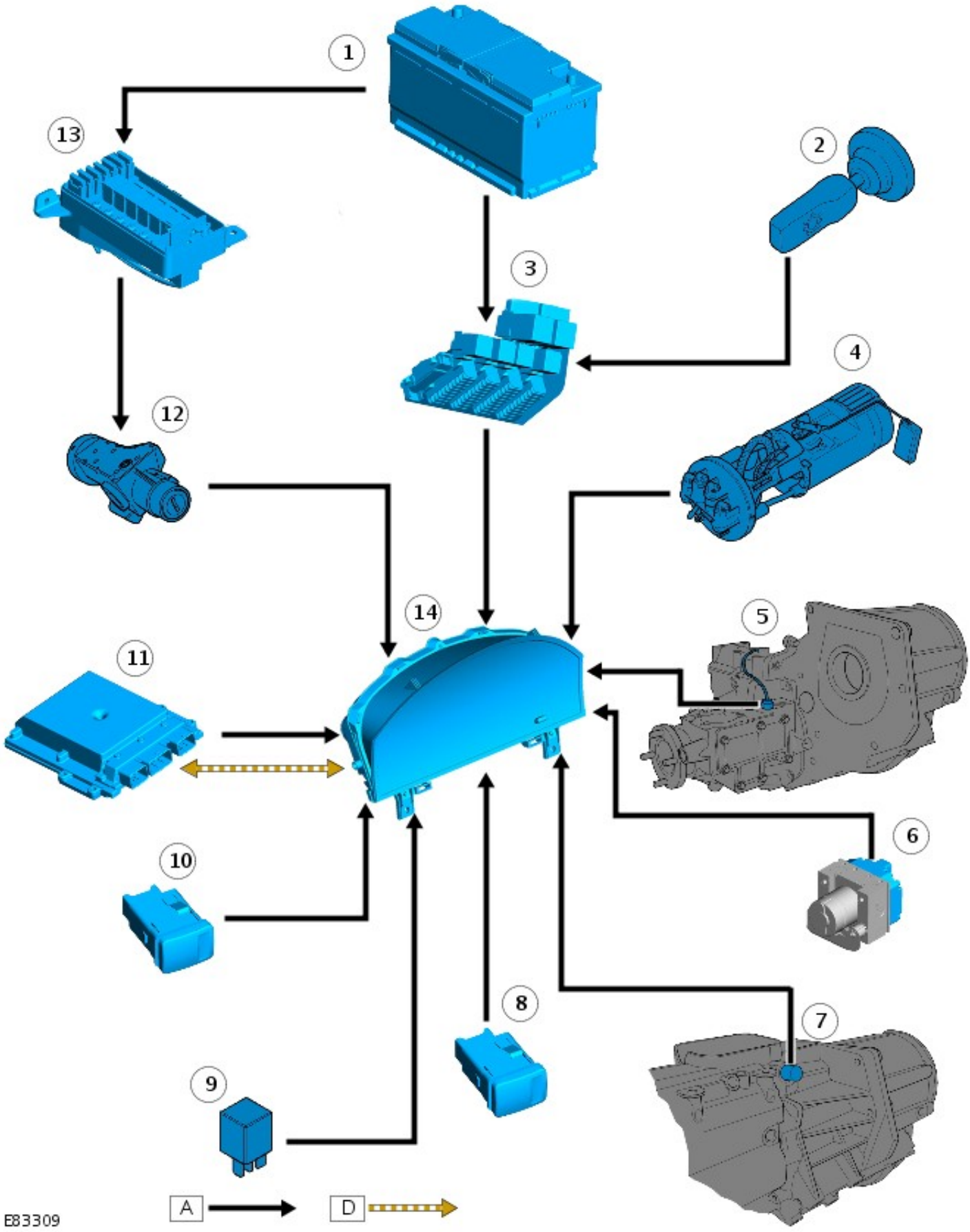
The following table shows the available indicators and indicates if they are subject to an indicator check at ignition on and if they are self or externally controlled.

Indicator Lamp	Illumination Color	Bulb Check	Self Controlled (S)/Externally Controlled (E)
Glow plugs active	Amber	No (may illuminate at ignition on to show glow plugs active)	E
Safety belt	Red	No	E
MIL	Amber	* Yes	E
Left turn signal	Green	No	E
High ECT	Red	Yes	S
High beam	Blue	No	E
Hazard flasher	Red	No	E
Right turn signal	Green	No	E
Traction control	Amber	Yes	E
Differential lock	Amber	No	E
Rear fog lamp	Amber	No	E
Trailer	Green	No	E
Low fuel	Amber	Yes	S
ABS	Amber	* Yes	E
Brake warning	Red	Yes	E
Side lamps on	Green	No	E
Anti-theft alarm	Red	No	E
Transfer box low range	Green	No	E
Ignition/No charge	Red	No	E
Low oil pressure	Red	No	E

* = Bulb check performed by sub-system module, not instrument cluster

CONTROL DIAGRAM - SHEET 1 OF 2

• NOTE: **A** = Hardwired; **D** = High speed CAN bus

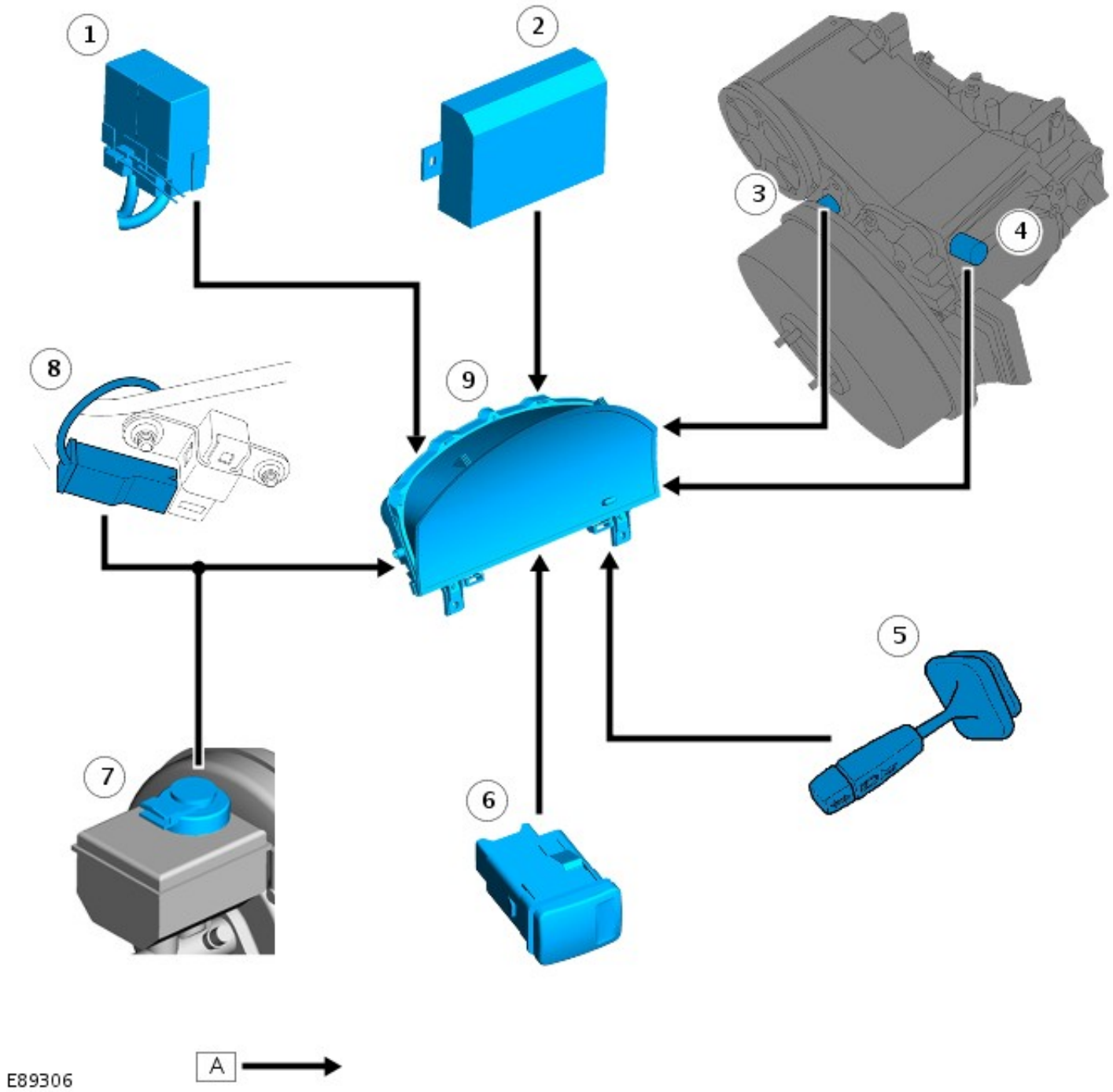


Item	Part Number	Description
1	-	Battery
2	-	Lighting switch
3	-	central junction box (CJB)
4	-	Fuel tank unit
5	-	Differential lock switch
6	-	ABS module

7	-	Reverse gear switch
8	-	Hazard flasher switch
9	-	Hazard flasher relay
10	-	Heated rear screen switch
11	-	ECM
12	-	Ignition switch
13	-	battery junction box (BJB)
14	-	Instrument cluster

CONTROL DIAGRAM - SHEET 2 OF 2

• NOTE: **A** = Hardwired



Item	Part Number	Description
1	-	Heated windshield timer unit
2	-	Anti-theft alarm control module
3	-	Vehicle speed sensor
4	-	High/Low range switch
5	-	Column switch - turn signal indicators
6	-	Rear fog lamp switch

7	-	Brake fluid level switch
8	-	Parking brake switch
9	-	Instrument cluster

PRINCIPLES OF OPERATION

Speedometer

The instrument cluster receives a hardwired vehicle speed signal from the vehicle speed sensor. The vehicle speed sensor is a Hall effect sensor located on the transfer box. The sensor acts on a reluctor ring located on the transfer box rear output shaft.
For additional information, refer to: Transfer Case - Vehicles With: 6-Speed Manual Transmission - MT82 (308-07A Transfer Case - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

Tachometer

The tachometer is driven by an engine speed signal transmitted on the high speed CAN bus from the ECM. The signal is derived from the crankshaft position (CKP) sensor. The signal is received by the instrument cluster microprocessor and the output from the microprocessor drives the tachometer.

Fuel Level Gauge

The instrument cluster calculates the amount of fuel in the tank by providing a reference current to the fuel tank level sensor. The fuel tank level sensor uses a float operated MAgnetic Passive Position Sensor (MAPPS) for measuring fuel tank contents.

The instrument cluster measures the returned output from the sensor, which is proportional to the level of the float arm and consequently the amount of fuel in the tank. The instrument cluster monitors the signal from the sensor at approximately 20 second intervals. This prevents the gauge needle pointer from continually moving due to the movement of fuel in the tank when cornering or braking.

Engine Coolant Temperature Gauge

The ECT gauge is driven by high speed CAN bus messages from the ECM. For normal operating temperatures the gauge needle pointer is positioned centrally in the gauge display. The needle pointer position translates to the following approximate temperatures.

Engine Coolant Temperature °C (°F)	Needle Pointer Position
Ignition off	Park position
40 (104)	Cold (blue segment)
75 - 115 (167 - 239)	Normal (central)
120 (248)	Start of hot (red segment)
125 (257)	End of hot

Glow Plugs Active Indicator

The glow plugs active indicator is illuminated by the instrument cluster software on receipt of a high speed CAN bus message from the ECM. The indicator illuminates in an amber color when the ignition is turned to position II. The indicator illumination period varies with ECT and if ECTis high, will not illuminate.

The indicator is controlled by high speed CAN bus messages from the ECM, which equate to the time the glow plugs are energized to pre-heat the combustion chambers. When the glow plug heating time is complete, the indicator is extinguished indicating to the driver that the engine can now be started.

Safety Belt Indicator

The safety belt indicator is controlled by a hardwired feed from switches located in the front seat safety belt buckles. The safety belt indicator is fitted to Gulf specification vehicles only.

Malfunction Indicator Lamp

The MIL is controlled by the instrument cluster software on receipt of a high speed CAN bus message from the ECM. The lamp is illuminated for a bulb check by the ECM when the ignition is moved to position II. The lamp is extinguished when the engine starts.

If the MIL remains illuminated after the engine is started or illuminates while driving, a fault is present and must be investigated at the earliest opportunity. Illumination of the MIL indicates there is an on-board diagnostic (OBD) fault which will cause excessive emissions output.

Left and Right Turn Signal Indicators

The turn signal indicators are controlled by the instrument cluster software on receipt of hardwired signals from the steering column switch. When the turn signal indicator switch is operated, the instrument cluster receives a signal feed from the column switch. The instrument cluster software controls the flash rate of the indicator which flashes in a green color. During normal turn signal indicator operation the indicator flashes slowly, accompanied simultaneously by a sound from the instrument cluster sounder. If a fault exists, the instrument cluster flashes the indicator at double speed.

High Engine Coolant Temperature Indicator

The high ECT indicator is illuminated on receipt of a high speed CAN bus message from the ECM. The indicator illuminates when the ignition is turned to position II for a 3 second bulb check and is extinguished when the engine is started. If the indicator illuminates while driving, a fault in the engine cooling system has become present and the engine must be stopped at the earliest opportunity.

High Beam Indicator

The high beam indicator is controlled by the instrument cluster software on receipt of a hardwired signal from the CJB. The signal from the CJB originates from the steering column switch when high beam is selected.

Hazard Flasher Indicator

The hazard flasher indicator is controlled by the instrument cluster software on receipt of a hardwired signal from the hazard flasher switch. The hazard flasher indicators can operate with the ignition switched off, flashing both the left and right turn signal indicators simultaneously.

Traction Control Indicator

The traction control indicator is illuminated by the instrument cluster software on receipt of a hardwired signal from the ABS module. The indicator is illuminated for 3 seconds for a bulb check when the ignition switch is turned to position II. If no fault exists, the indicator is extinguished after the bulb check period.

When traction control is active, the indicator flashes to inform the driver that the system is regulating engine output.

Heated Windshield Indicator

In order for the heated windshield to operate, the engine must be running. The instrument cluster receives an engine running signal from the ECM over the high speed CAN bus. On receipt of this message, the instrument cluster provides a hardwired signal to the heated windshield timer relay. If heated windshield operation is subsequently requested a ground path is created via the heated windshield switch. When the instrument cluster registers the ground, it illuminates the heated windshield indicator.

Differential Lock Indicator

The differential lock indicator is illuminated on receipt of a hardwired signal from the differential lock switch. The indicator will illuminate at all times when the differential lock is selected and the ignition switch is in position II.

Rear Fog Lamp Indicator

The rear fog lamp indicator is illuminated on receipt of a hardwired signal from the rear fog lamp switch. The indicator will illuminate at all times when the rear fog lamps are selected on and the ignition switch is in position II.

Trailer Indicator

The trailer indicator is controlled by the instrument cluster software on receipt of a hardwired signal from the hazard flasher relay. When a trailer is connected, the hazard flasher relay energizes and provides a feed to the instrument cluster. The feed across the hazard flasher relay originates from the steering column switch. The instrument cluster software controls the flash rate of the indicator which flashes in a green color. The trailer indicator flashes slowly, accompanied simultaneously by a chime from the instrument cluster sounder, at the same rate as the turn signal indicators.

Low Fuel Indicator

The instrument cluster calculates the amount of fuel in the tank by providing a reference current to the fuel tank level sensor. If the cluster determines the level of fuel within the tank is at or below 14 liters (3.69 gallons) it will illuminate the low fuel indicator and emit a single chime. For more information, refer to 'Fuel Level Gauge' above.

ABS Indicator

The ABS indicator is controlled by the ABS module which transmits a hardwired signal to the instrument cluster. The indicator is illuminated in an amber color for a 3 second bulb check by the ABS module when the ignition is turned to position II. If the indicator remains illuminated or illuminates when driving, an ABS fault has occurred and the ABS function will not be available.

The ABS module will alert the driver that a diagnostic trouble code (DTC) has been stored in its memory during the bulb check process. It will do this by;

- illuminating the indicator for 0.5 seconds
- extinguishing the indicator for 0.5 seconds
- illuminating the indicator for 2 seconds.

If the indicator is illuminated for a sensor fault, the indicator will remain illuminated at the next ignition cycle, even if the fault is rectified. When the vehicle is driven above a speed of 20 km/h (12.5 mph) the indicator will be extinguished. This allows the ABS module to perform a thorough check of the system and to establish that the output from the replaced sensor is correct.

Brake Warning Indicator

The brake warning indicator is illuminated for a 3 second bulb check when the ignition is turned to position II. The indicator will also illuminate if the parking brake is on, or the brake fluid falls below a pre-determined level. The instrument cluster is hardwired to the parking brake switch and the brake fluid level switch, which are connected in parallel. If either of the conditions above are met a ground path is created, illuminating the indicator.

Side Lights On Indicator

The side lights on indicator is controlled by the lighting switch. When the lighting switch is turned to the side or headlamp position, a hardwired feed is provided to the instrument cluster via the CJB. On receipt of the hardwired feed, the instrument cluster illuminates the indicator.

Anti-theft Alarm Indicator

Illumination of the anti-theft alarm indicator is controlled directly by the anti-theft alarm control module. For additional information, refer to:

Anti-Theft - Active (419-01A Anti-Theft - Active, Description and Operation),
Anti-Theft - Passive (419-01B Anti-Theft - Passive, Description and Operation).

Transfer Box Low Range Indicator

The transfer box high/low range switch is hardwired to the instrument cluster. When low range is selected, the transfer box provides a feed to instrument cluster, which subsequently illuminates the green low range indicator. The low range indicator remains permanently illuminated until high range is selected and the feed from the high/low range switch is removed.

Ignition/No Charge Warning Indicator

The ignition/no charge indicator is controlled by the instrument cluster software and illuminated on receipt of a high speed CAN bus message from the ECM. The indicator illuminates in a red color when the ignition is turned to position II and is extinguished when the engine is started.

If the indicator remains illuminated after the engine has started or illuminates when driving, the alternator charge output has failed.

Low Oil Pressure Warning Indicator

The low oil pressure indicator is controlled by the instrument cluster software and illuminated on receipt of a high speed CAN bus message from the ECM. The indicator is illuminated in a red color when the ignition switch is turned to position II. When the engine is started and the oil pressure increases the low oil pressure indicator should extinguish. If the indicator remains illuminated or illuminates when driving the vehicle should be stopped at the earliest opportunity and the engine switched off until the fault is rectified.

Instrument Cluster Replacement

If a new instrument cluster is to be fitted, the Land Rover approved diagnostic system must be connected to the vehicle and the instrument cluster renewal procedure run. This will ensure that vehicle coding data is correctly installed in the new instrument cluster. The Land Rover approved diagnostic system will also record the current service interval data and restore the settings to the new instrument cluster.

Instrument Cluster - Instrument Cluster
Diagnosis and Testing

Overview

The instrument cluster is a totally electronic device which receives analogue or digital signals via hardwired or bus system for instrumentation operation. The signals which are processed by the engine control module (ECM) are transmitted via controller area network (CAN) to the instrument cluster and displayed as analogue gauge indications or warning lamp illuminations. The instrument cluster is connected to the vehicle electrical system by one connector which provides all input and output connections. No components of the instrument cluster are serviceable. The instrument cluster has two main functions to provide information to the driver of the vehicle status and to process and relay digital signals. The instrument cluster identifies the signals and displays the appropriate message in the message center. For information on the operation of the systems:
REFER to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation) / Communications Network (418-00 Module Communications Network, Description and Operation).

Car Configuration File (CCF)

CAUTION: If a new instrument cluster is to be installed, the instrument cluster renewal procedure must be carried out using the approved diagnostic system. This will make sure that the car configuration file (CCF) data is correctly transferred from the ECM to the replacement instrument cluster. The CCF will also need to be updated using the approved diagnostic system if the vehicle is modified in service from its original factory specification. This can include the fitting of non-standard wheels and/or tires and optional dealer fit accessory components with an electrical interface, such as parking aid.

The CCF contains all relevant data about the specification and market condition of the applicable vehicle, immobilization codes and driver personal settings. This information is retained in the ECM and the instrument cluster enabling each system module to detect which systems and components are fitted to the vehicle. The information is continuously transferred between these two system modules to make sure that the data is constantly backed-up between the modules.

Inspection and Verification

1. **1.** Verify the customer concern.
2. **2.** Confirm which, if any, warning lights were displayed on the instrument cluster.
3. **3.** Visually inspect for obvious electrical faults.

Visual inspection

Electrical
• Battery and passenger junction box fuses • Read diagnostic trouble codes (DTCs) - Using the approved diagnostic system or a scan tool • Damaged, loose or corroded connectors • Instrument cluster for any external damage • Electrical circuits

4. **4.** If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
5. **5.** Use the approved diagnostic system or a scan tool to retrieve any DTCs before moving onto the DTC index.
    - Make sure that all DTCs are cleared following rectification.

DTC Index

• NOTE: If a control module or 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 program is in operation, before the replacement of a component.

• NOTE: Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

• NOTE: When performing 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: Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

• 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.

DTC	Description	Possible cause(s)	Action
U000188	High speed controller area network (CAN) bus off fault	• CAN circuit: short circuit to each other • CAN circuit: short circuit to power • CAN circuit: short circuit to ground • Engine control module (ECM) fault • Instrument cluster fault	Carry out a complete vehicle read for DTCs indicating a CAN circuit or module fault. Rectify as necessary. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
B1A7501	Fuel sender 1-general electrical error	• Fuel level sender circuit: short circuit to ground • Fuel level sender circuit: short circuit to power • Fuel level sender circuit: open circuit • Fuel sender fault • Instrument cluster fault	Check the fuel level sender and circuits. Refer to the electrical guides. Install a new fuel level sensor if necessary, REFER to: Fuel Level Sender (310-01 Fuel Tank and Lines - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation). . Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if the instrument cluster is suspect.
B1A8164	Internal trip switch plausibility fault	• Instrument cluster fault	Check the instrument cluster circuits. Refer to the electrical guides. Clear the DTC. Cycle the ignition and retest. If the DTC resets, suspect the instrument cluster. Refer to the warranty policy and procedures manual if the instrument cluster is suspect.
P160231	Immobilizer/engine control module (ECM) communication error – no signal	• Alarm (immobiliser) - instrument cluster circuit: short circuit to ground • Alarm (immobiliser) - instrument cluster circuit: short circuit to power • Alarm (immobiliser) - instrument cluster circuit: open circuit • ECM fault • Instrument cluster fault	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the alarm (immobilizer) circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
U010087	Lost controller area network (CAN) communication – engine control module (ECM)	• CAN circuit: open circuit • ECM fault • Instrument cluster fault	Carry out a complete vehicle DTC read. Check for other CAN DTCs or apparently unrelated customer complaints. Check the CAN and module power and ground circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
U040168	Invalid data received from	• Incorrect signals	Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation. Check the sensor signal circuits. Refer to the

	engine control module (ECM)	received from ECM	electrical guides. Rectify as necessary. Clear the DTCs and test for normal operation.
U210100	Control module configuration incompatible	• Central car configuration parameter missing or corrupted	Check correct central car configuration software is installed. Reprogramme the instrument cluster as necessary.
U300017	Control module over voltage	• Vehicle started using a booster pack • Supply voltage has exceeded 17.4v for 12 seconds • Charging system over charging	Check the instrument cluster supply circuits. Check the charging system and charging voltage. Refer to the electrical guides. Rectify as necessary. Clear the DTC. Cycle the ignition and retest. Refer to the warranty policy and procedures manual if the instrument cluster is suspect.
U300046	Control module electrically eraseable programmable read only memory (EEPROM) error	• Power supply lost from the instrument cluster with the ignition on • Instrument cluster fault	Check the instrument cluster circuits. Refer to the electrical guides. Rectify as necessary. Clear the DTC. Cycle the ignition and retest. Configure the module using the approved diagnostic system. If the DTC resets suspect the instrument cluster. Refer to the warranty policy and procedures manual if the instrument cluster is suspect.

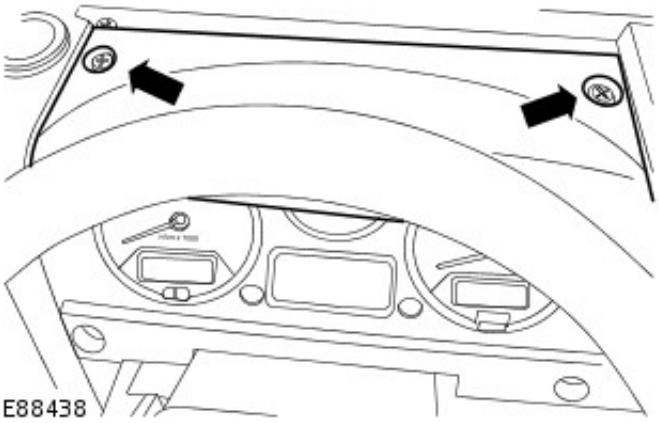
Instrument Cluster - Instrument Cluster
Removal and Installation

Removal

1. Disconnect the battery ground cable.
For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).

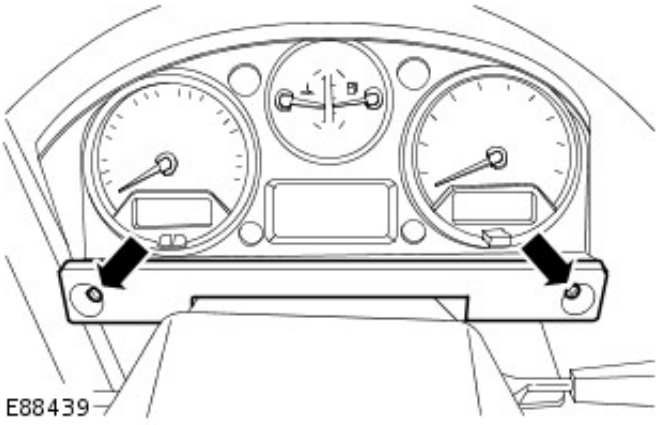
2. Remove the instrument cluster upper finisher.

- Remove the 2 screws.



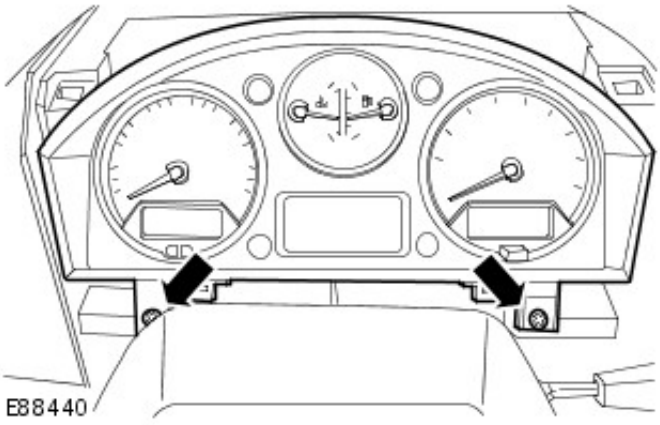
3. Remove the instrument cluster lower finisher.

- Remove the 2 screws.

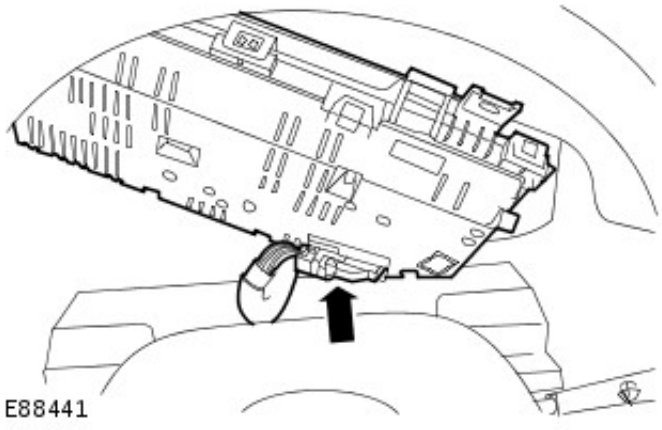


4. Release the instrument cluster.

- Remove the 2 screws.



5. Remove the instrument cluster.

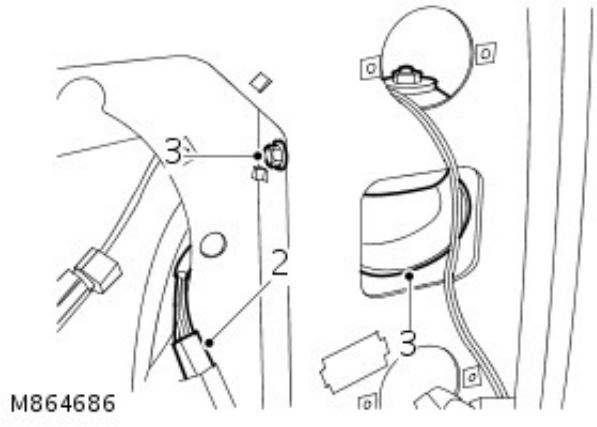


- Disconnect the electrical connector.

Installation

1. Install the instrument cluster.
   - Connect the electrical connector.
2. Secure the instrument cluster.
   - Install the 2 screws.
3. Install the instrument cluster lower finisher.
   - Install the 2 screws.
4. Install the instrument cluster upper finisher.
   - Install the 2 screws.
5. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).
6. Using the approved Land Rover diagnostic equipment, configure the instrument cluster.

Horn - Horn
Removal and Installation



Removal

1. Remove LH headlamp.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
2. Disconnect horn multiplug.
3. Remove nut and remove horn from mounting bracket.

Installation

1. Position horn, tighten securing and connect multiplug.
2. Fit LH headlamp.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

Clock -

Torque specifications

Description	Nm	lb-ft
Clock support bracket	1	1

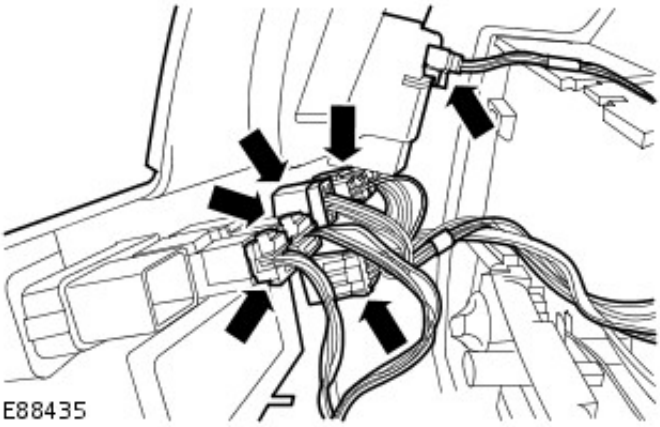
Clock - Clock
Removal and Installation

Removal

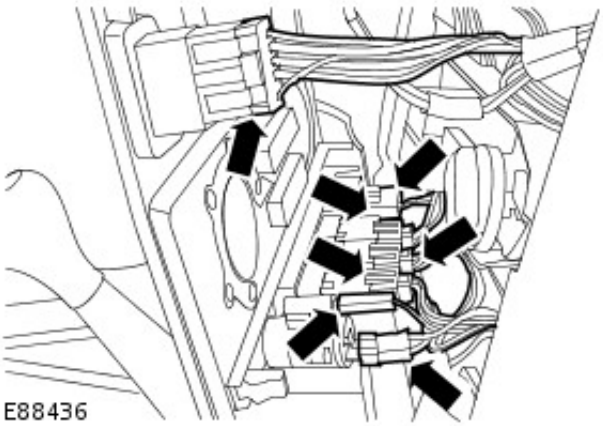
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. Release the instrument panel console.

E88434

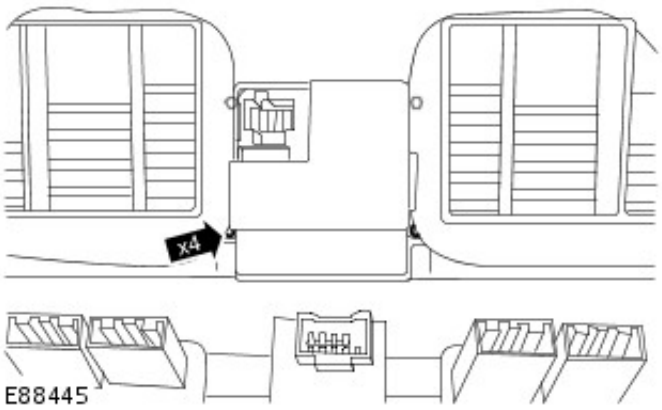
4. Disconnect the 6 electrical connectors.


E88435

5. Remove the instrument panel console.
   - Disconnect the 7 electrical connectors.

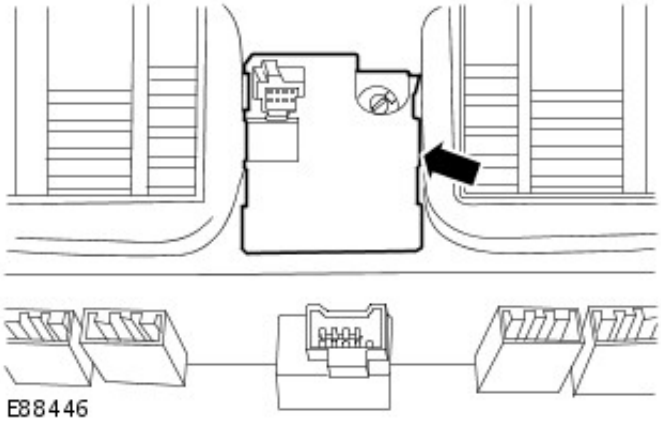

E88436

6. Remove the clock support bracket.



- Remove the 4 screws.

7. Remove the clock.



Installation

1. To install, reverse the removal procedure.

2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Charging System - General Information - Charging System

Diagnosis and Testing

Generator testing

Charging system check

- Check battery is in good condition, with an open circuit voltage of at least 12.6 V. Recharge or substitute battery to carry out test.
- **1.** Check drive belt condition.
- **2.** Check battery connections are clean and tight.
- **3.** Check generator connections are clean and tight.
- **4.** Ensure there is no drain on battery from, for example, interior or exterior lamps.

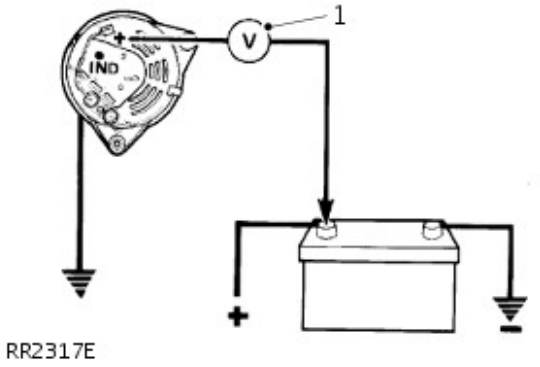
Generator test

Following instructions refer to use of suitable test equipment using a carbon pile rheostat.

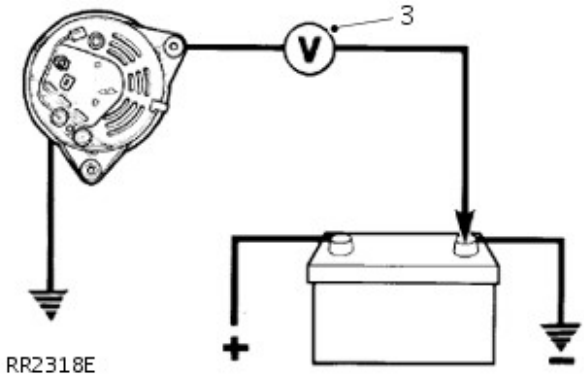
- Connect test equipment referring to manufacturer's instructions.
- Start engine and run at 3000 rev/min without accessory load.
- Rotate carbon pile load control to achieve greatest output (amps) without allowing voltage to fall below 12.0 V. A reading in amps, of generator output should be obtained.
- Run engine at 3000 rev/min, switch selector to regulator test, read voltmeter. A reading of 13.6 to 14.4 V should be obtained.
- Switch selector to diode/stator test, switch on headlamps to load generator. Raise engine speed to 3000 rev/min, read voltmeter, needle must be within 'OK' range.

Charging circuit resistance test

- Connect a low range voltmeter between generator terminal marked B+ and positive terminal of battery.



- **1.** Connect a low range voltmeter between generator terminal marked B+ and positive terminal of the battery.
- **2.** Switch on headlamps, start engine. Run engine at approximately 3000 rev/min. Note voltmeter reading.
- **3.** Transfer voltmeter connections to frame of generator and negative terminal of battery, and again note voltmeter reading.



- **4.** If reading exceeds 0.5 volt on positive side or 0.25 volt on negative side, there is a high resistance in charging circuit which must be traced and remedied.

Battery, Mounting and Cables -

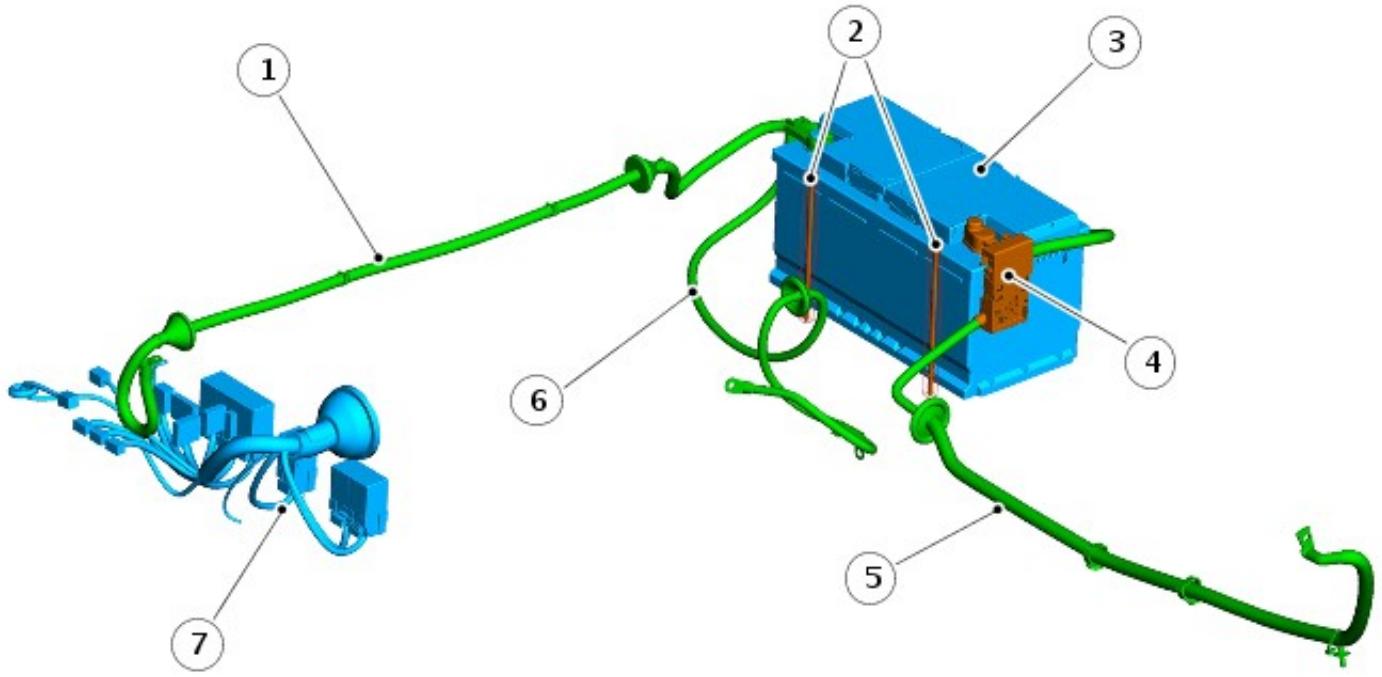
Torque specifications

Description	Nm	lb-ft
Battery terminal nuts	5	4
Battery clamp nuts	9	7
Battery ground cable to transmission stud	30	22

Battery, Mounting and Cables - Battery and Cables
Description and Operation

COMPONENT LOCATION

Battery Junction Box



E85651

Item	Part Number	Description
1	-	Power feed to battery junction box (BJB)
2	-	Battery clamps
3	-	Battery
4	-	Mega fuse
5	-	+VE battery cable
6	-	-VE battery cable
7	-	BJB

OVERVIEW

The battery is mounted in a protective box, located under the LH seat. It sits in a tray and is secured with clamp plates and bolts.

The battery terminal posts allow for the battery cables to be connected with clamp type connections.

The battery positive terminal is fitted with a mega fuse, which is a 500 Amp device housed in a black fuse carrier, integral to the battery clamp. Power feed to the BJB is taken from a tap on the battery clamp before the mega fuse.

In the event of a crash the mega fuse is designed to blow, this isolates the power from the generator and starter motor, but allows power to be delivered, via the central junction box (CJB), to the rest of the vehicle.

The battery is a .

The battery is a H8, semi-sealed type. Each casing has a vent to allow for thermal expansion and to vent oxygen and hydrogen gases, which are produced under certain charging conditions.

When removing the battery, ensure the alarm is disarmed and the ignition is switched off. Always disconnect the negative terminal first and then the positive. When refitting the battery, always fit the positive terminal first followed by the negative.

If the battery requires recharging, always use an approved constant current charger, designed for lead-calcium

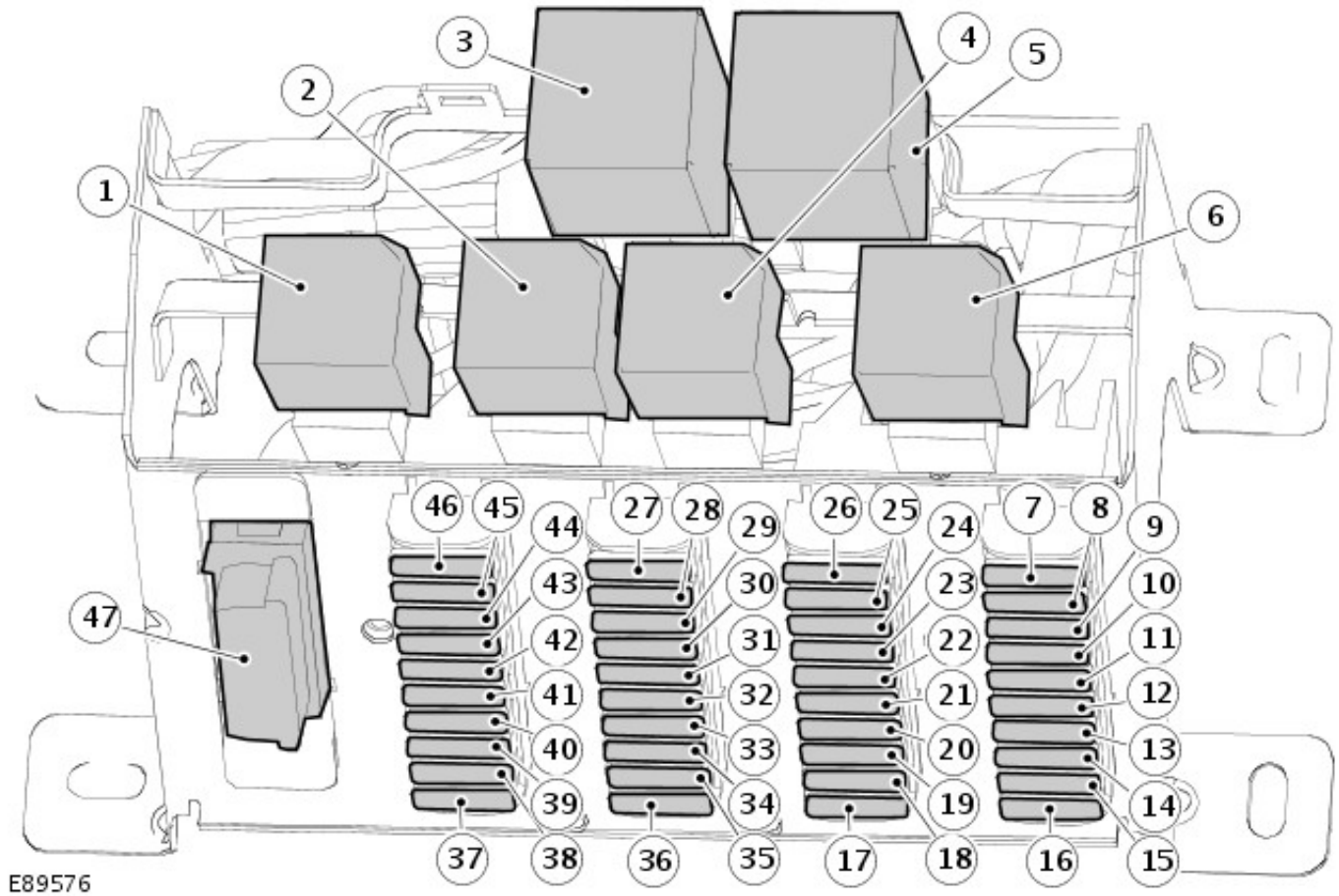
batteries. DO NOT use a fast charger, as permanent damage to the battery may occur.

Starter Fuse

Incorporated in the cable between the battery and the starter motor/generator is a 500A mega 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.

CENTRAL JUNCTION BOX

• NOTE: LH drive shown .



CJB Relay Descriptions

Location	Description
1	Headlamp relay
2	Heated rear window relay
3	Wipers relay
4	Electric window lift relay
5	Indicator flasher relay
6	Alarm relay

CJB Fuse Descriptions

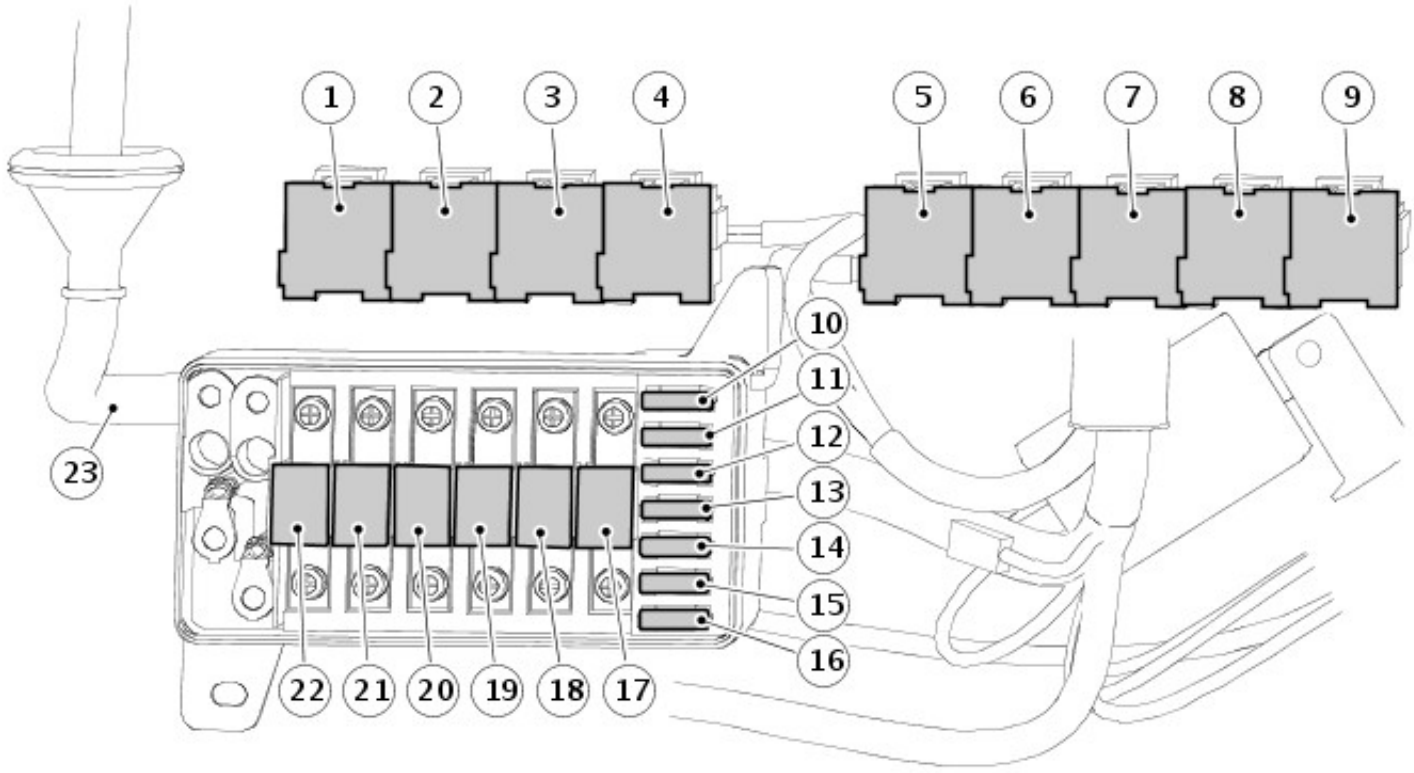
Name	Item Number	Rating (Amps)	Fuse color	Circuits protected
F8	16	10	Red	Alarm system
F9	15	15	Blue	Front wipers/wash
F10	14	10	Red	Rear wipers/wash
F11	13	10	Red	Anti-lock brakes
F12	12	10	Red	Speed transducer
F13	11	10	Red	Brake lamps
F14	10	10	Red	Reverse lamps
F15	9	5	Tan	Ignition
F16	8	-	-	Not used
F17	7	-	-	Not used
F18	17	10	Red	Side lamps (left)
F19	18	10	Red	Side lamps (right)
F20	19	10	Red	Illumination/clock illumination
F21	20	10	Red	Hazard switch

F22	21	10	Red	Headlamp dipped beam (right)
F23	22	10	Red	Headlamp dipped beam (left)
F24	23	10	Red	Headlamp main beam (right)
F25	24	10	Red	Headlamp main beam (left)
F26	25	10	Red	Rear fog lamps
F27	26	10	Red	Alarm sounder
F28	36	20	Yellow	Heated rear window
F29	35	20	Yellow	Cooling fan/A/C clutch link
F30	34	10	Red	Audio/clock/diagnostic socket
F31	33	15	Blue	Hazard switch
F32	32	-	-	Not used
F33	31	20	Yellow	Seat heater
F34	30	20	Yellow	Electric window (right)
F35	29	20	Yellow	Electric window (left)
F36	28	30	Green	Heated front screen
F37	27	30	Green	Spare fuse
F38	37	10	Red	Engine ECU/PCM
F39	38	5	Tan	Engine ECU/PCM
F40	39	-	-	Not used
F41	40	5	Tan	Engine ECU/PCM
F42	41	10	Red	Air conditioning switch
F43	42	20	Yellow	Cigar lighter
F44	43	5	Tan	Audio unit
F45	44	30	Green	Blower motor
F46	45	-	-	Not used
F47	46	-	-	Not used
Diagnostic socket	47	-	-	Diagnostic socket

The Central Junction box is located below and to one side of the steering column. The fuses are accessed by turning the fixing screws fully counterclockwise and removing the cover.

• NOTE: Some early 07MY vehicles have a handed CJB. The illustration above shows the left-hand (LH) drive variant fitted to all other vehicles. The early right-hand (RH) drive version is a mirror image of the standard LH drive CJB.

BATTERY JUNCTION BOX



E89575

BJB Relay Descriptions

Item Number	Description
1	anti-lock brake system (ABS) pump relay
2	Main relay
3	Starter relay
4	Glow plug relay
5	Aircon clutch relay
6	Aircon cooling fan relay
7	Aircon accessory relay
8	Heated front screen relay
9	Heated screen timer relay

BJB Fuse Descriptions

Name	Item Number	Rating (Amps)	Fuse color	Circuits protected
F1	16	30	Green	Anti-lock braking
F2	15	20	Yellow	Accessory socket
F3	14	20	Yellow	Headlamp flash/horn
F4	13	20	Yellow	Not used
F5	12	30	Green	Main relay/engine control module (ECM)
F6	11	15	Blue	Alarm system
F7	10	20	Yellow	Alarm system

BJB Link Fuse Descriptions

Item Number	Rating (Amps)	Fuse color	Circuits protected
22	100	Blue	Glow plug relay, fusible links 2,3 and 4, fuses 1,2 and 3 and fuse 36 in the CJB
21	60	Yellow	CJB Batt feed
20	60	Yellow	Window lift relay
19	30	Green	ABS return pump
18	60	Yellow	Ignition switch/starter relay
17	30	Green	Lighting switch
23	-	-	Main battery power feed

The Battery Junction Box is located under the right front seat and is accessed by removing the seat base.

Battery, Mounting and Cables - Battery Connect

General Procedures

• WARNINGS:

Batteries normally produce explosive gases which may cause personal injury, therefore do not allow lighted substances to come near the battery. When charging or working near the battery always shield your face and protect your eyes. Always provide adequate ventilation. Failure to follow these instructions may result in personal injury.

Batteries contain sulphuric acid, avoid contact with skin, eyes or clothing. Shield your face and protect your eyes when working near the battery to guard against possible splashing of the acid solution. In case of acid contact with the skin or eyes, flush immediately for a minimum of 15 minutes and seek prompt medical attention. If swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

CAUTION: Make sure all electrical systems are OFF before connecting the battery ground cable. Failure to follow this instruction may result in damage to the vehicles electrical system.

1. Connect the battery ground cable.

- Tighten the nut to 10 Nm (7 lb.ft).

2. Install the battery cover.

- Secure with the clip.

3. Install LH front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

4. Enter the audio unit keycode and preset radio frequencies.

5. Reset the clock to the correct time.

Battery, Mounting and Cables - Battery Disconnect and Connect

General Procedures

• WARNINGS:

Batteries normally produce explosive gases which may cause personal injury, therefore do not allow lighted substances to come near the battery. When charging or working near the battery always shield your face and protect your eyes. Always provide adequate ventilation. Failure to follow these instructions may result in personal injury.

Batteries contain sulphuric acid, avoid contact with skin, eyes or clothing. Shield your face and protect your eyes when working near the battery to guard against possible splashing of the acid solution. In case of acid contact with the skin or eyes, flush immediately for a minimum of 15 minutes and seek prompt medical attention. If swallowed, call a physician immediately. Failure to follow these instructions may result in personal injury.

CAUTION: Make sure the engine is not running before disconnecting the battery ground cable. Failure to follow this instruction may result in damage to the vehicles electrical system.

• NOTE: This procedure should be used to disconnect the battery while carrying out repairs that refer to the battery being disconnected.

• NOTE: Before disconnecting the battery make sure that no data is required from the engine control module (ECM), as battery cable disconnection will erase any fault codes and idle/drive values held in the keep alive memory (KAM).

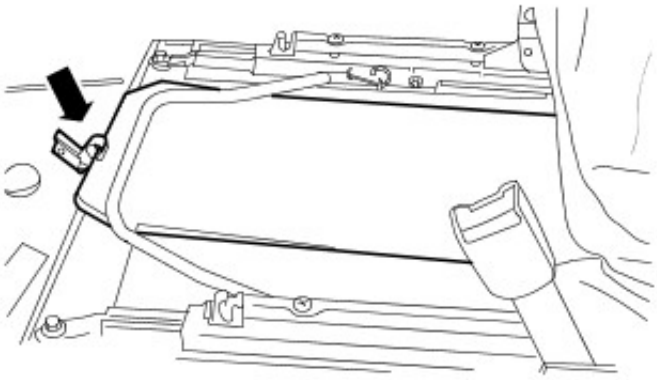
1. Obtain and record the audio unit keycode and preset radio frequencies.

2. Remove the LH front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

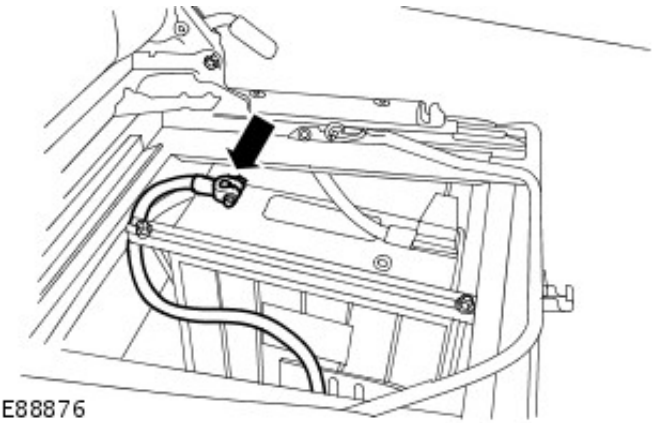
3. NOTE: RH illustration is shown, LH is similar.

Remove the battery cover.

- Release the clip.



E89791



E88876

4. CAUTION: Failure to follow the procedure below could result in the alarm sounder self activating when the battery is disconnected.

Disconnect the battery ground cable.

- Loosen the nut.
- Turn the ignition key to the run position.
- Turn the ignition key to the off position.
- Within 17 seconds of turning the ignition key to the off position, release the battery ground cable from the battery.

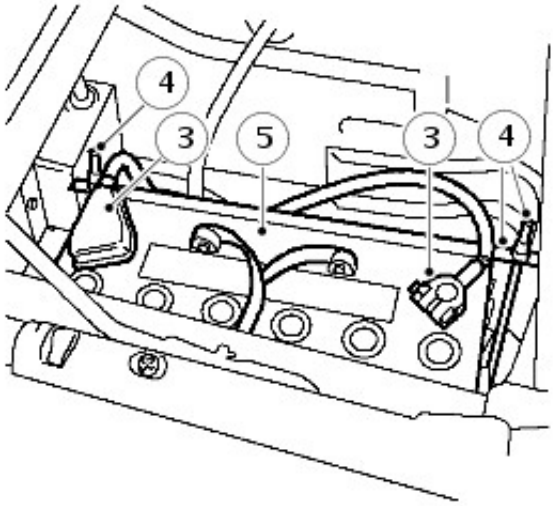
Battery, Mounting and Cables - Battery

Removal and Installation

Removal

1. Remove LH front seat cushion.
2. Release retaining clip and remove battery access cover.
3. WARNING: During battery removal or before carrying out any repairs or maintenance to electrical components always disconnect negative lead first. If positive lead is disconnected with negative lead in place, accidental contact of a wrench to any grounded metal part could cause a severe spark, possibly resulting in personal injury. Upon installation of battery always connect positive lead first.

   Disconnect both battery leads, negative first.
4. Slacken securing nuts and move battery clamp, with 'J' bolts aside.
5. Remove battery.



J6081

Installation

1. NOTE: Coat battery clamps and terminals with petroleum jelly before refitting.

   Position battery and secure with clamp. Ensure 'J' bolts are hooked correctly under retaining brackets on base of battery box.
2. Reconnect battery leads, positive lead first.
3. Install battery access cover.
4. Install seat cushion.

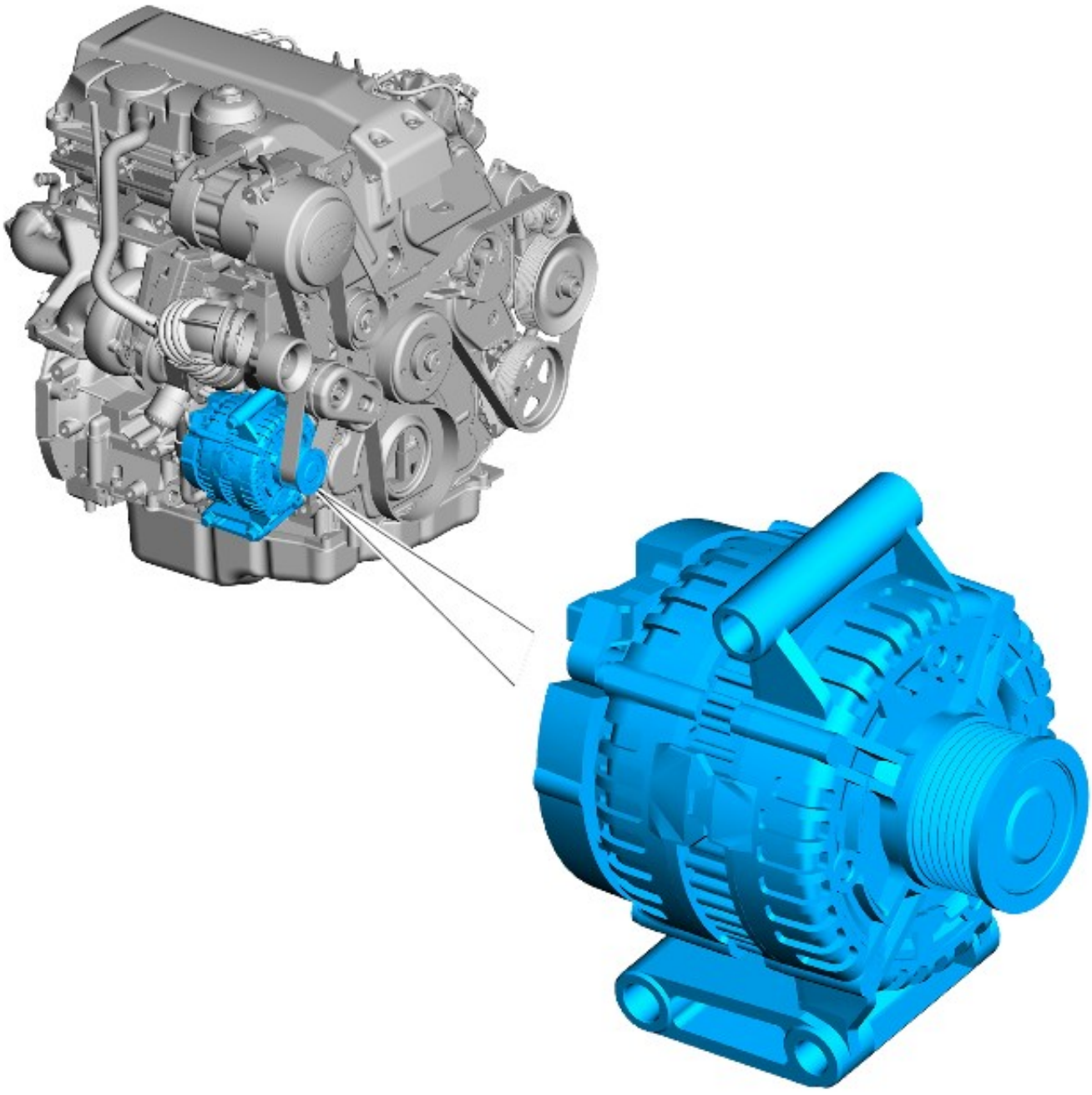
Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma -

Description	Nm	lb-ft
Generator battery positive cable nut	8	6
Generator bolts	48	35

Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Generator2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma

Description and Operation

COMPONENT LOCATION



E85648

OVERVIEW

The generator is located at the front RH side of the engine. The generator has an output of 85/150 Amps and is manufactured by Denso. An eight-ribbed polyvee belt drives the generator pulley, which in turn is driven from the engine crankshaft pulley.

The generator pulley incorporates a one-way clutch mechanism, which allows the pulley to free wheel, reducing the amount of inertia applied to the engine during deceleration (coast). The generator comprises a stator, a rotor, a rectifier pack and a regulator.

The generator is connected to ground via its mountings.

The rotor comprises a field winding, wound around an iron core and mounted on a shaft. The iron core has extensions at each end, which form North and South poles as current flows through the field winding. The rotor is located inside the stator and is mounted on bearings for smooth running and to support the rotor due to the high side loading applied by

the drive belt tension.

The stator has three sets of coils made from copper wire. The three coil windings are connected in a 'star' connection, where one end of the winding is connected to the other two windings. The output current is supplied from the opposite end of each winding. Rotation of the rotor causes ac current to be produced in the coils.

The rectifier converts the ac current produced in the stator coils into dc (rectified) current required by the vehicle electrical system. The rectifier comprises semi-conductor diodes mounted on a heatsink to dissipate heat. An equal number of the diodes are on the negative and positive side. An additional diode in the regulator controls feedback through the battery voltage signal line. The rectifier also prevents current flow from the battery to the generator when the output voltage is less than the battery voltage.

The 'smart' regulator controls the output voltage from the generator to protect the battery; at low temperatures battery charge acceptance is very poor so the voltage needs to be high to maximise any re-chargeability, but at high temperatures the charge voltage must be restricted to prevent excessive gassing with consequent water loss. The Engine Management System (EMS), which controls the regulator, will calculate the voltage set point required for the ensuing conditions. The 'traditional' regulator controls voltage against generator temperature, which means the battery temperature will lag a long way behind so there will be significant periods of operation when battery charging is compromised. With this system, the EMS can set the voltage by inferring the battery temperature from information received from it's various sensors, hence voltage will accurately follow the battery's needs.

The regulator has transistors, which rapidly switch on and off to regulate the voltage output according to the voltage sensed internally. The regulator also provides a PWM signal output to the ECM, which uses the signal to adjust the idle speed under varying electrical loads.

Initially, the ignition switch supply provides an excitation current to the rotor at low generator speeds via brushes, which contact slip rings at the end of the rotor shaft. As the generator speed increases the generator becomes self-exciting.

The charge warning lamp function is transmitted to the EMS and then on to the Controller Area Network (CAN) bus to the instrument cluster.

LOAD MANAGEMENT SYSTEM

The load management system comprises software resident in the Automatic Temperature Control (ATC) module .For additional information, refer to:Control Components (412-04 Control Components, Description and Operation). Its purpose is to protect battery state-of-charge during abnormal usage of the vehicle. The system will request the Media Orientated System Transport (MOST) ring and the air suspension to go into 'power save' mode, and will modulate features such as seat heating and screen heating to prevent the battery being dragged down to a point where the car becomes un-operational. A 'WARNING - LOW BATTERY' message will be displayed in the message center.

Generator and Regulator - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma - Generator

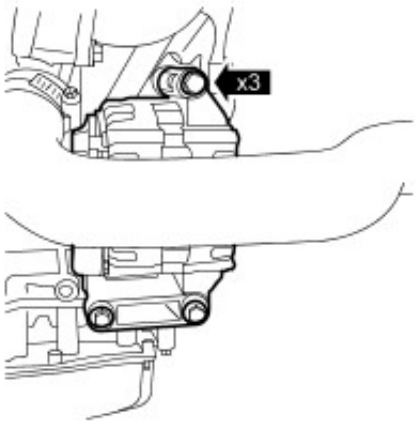
Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the accessory drive belt.
   For additional information, refer to: Accessory Drive Belt (303-05 Accessory Drive - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
3. Remove the air cleaner outlet pipe.
   For additional information, refer to: Air Cleaner Outlet Pipe (303-12 Intake Air Distribution and Filtering - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
4. NOTE: The generator upper bolt can only be removed when the generator has been released from the accessory drive component bracket.

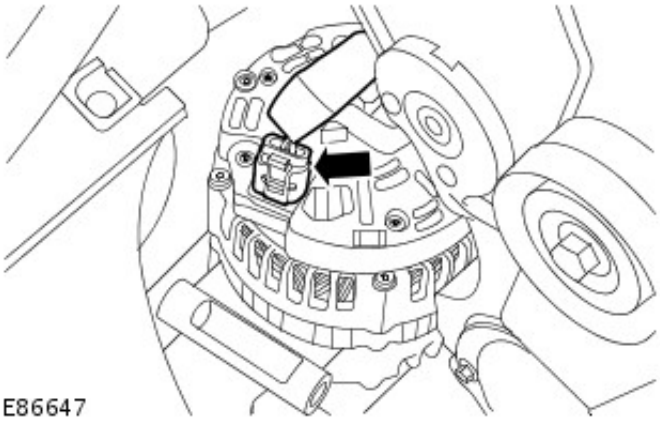
   Release the generator.

   - Remove the 3 bolts.

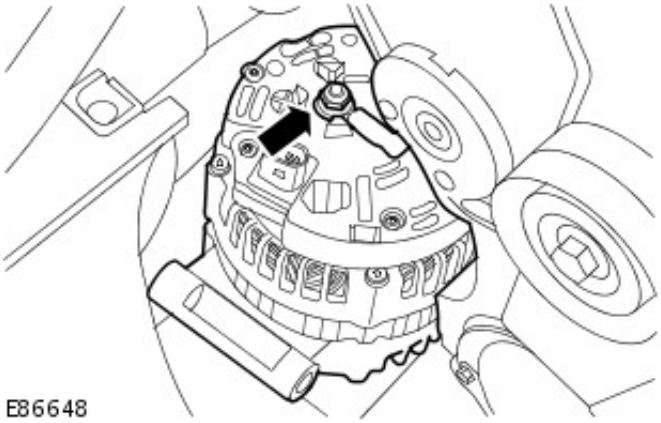


E86646

5. Disconnect the generator electrical connector.


E86647

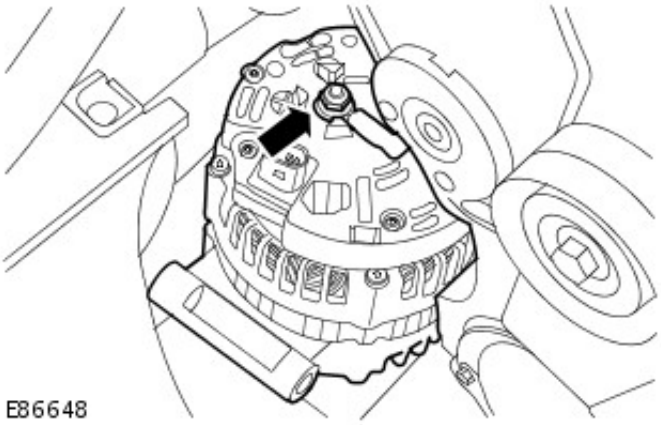
6. Remove the generator.
   - Remove the battery positive cable nut.
   - Release the battery positive cable.


E86648

Installation

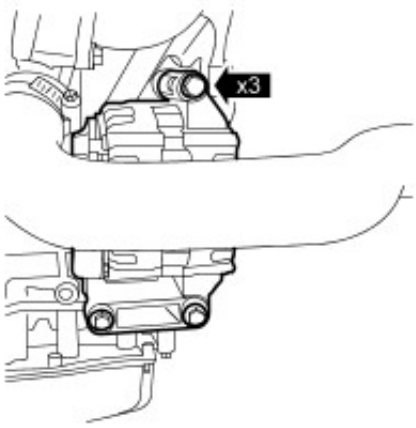
1. To install, reverse the removal procedure.

2. Tighten to 8 Nm (6 lb.ft).



E86648

3. Tighten to 48 Nm (35 lb.ft).

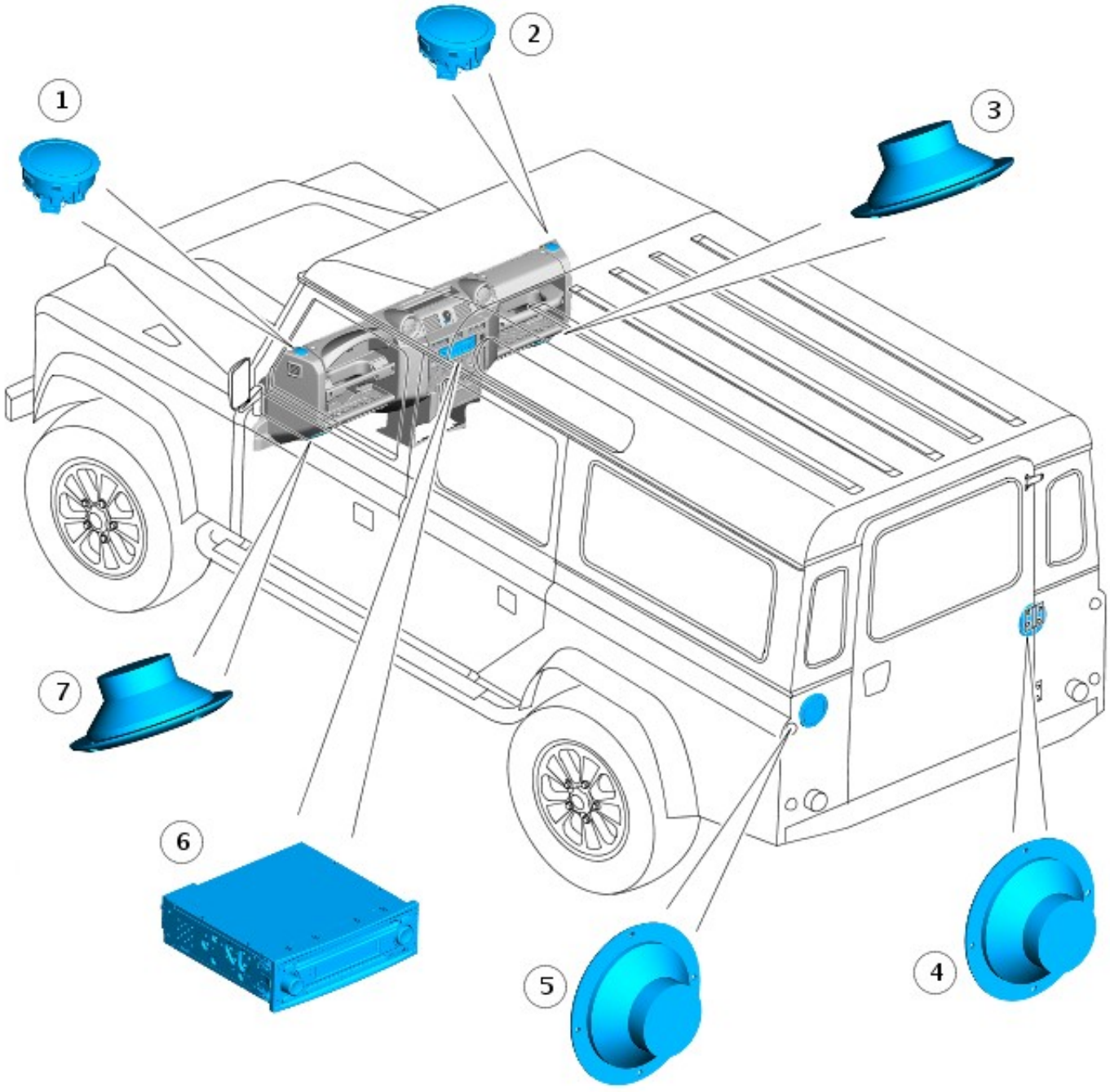


E86646

Audio Unit - Audio System

Description and Operation

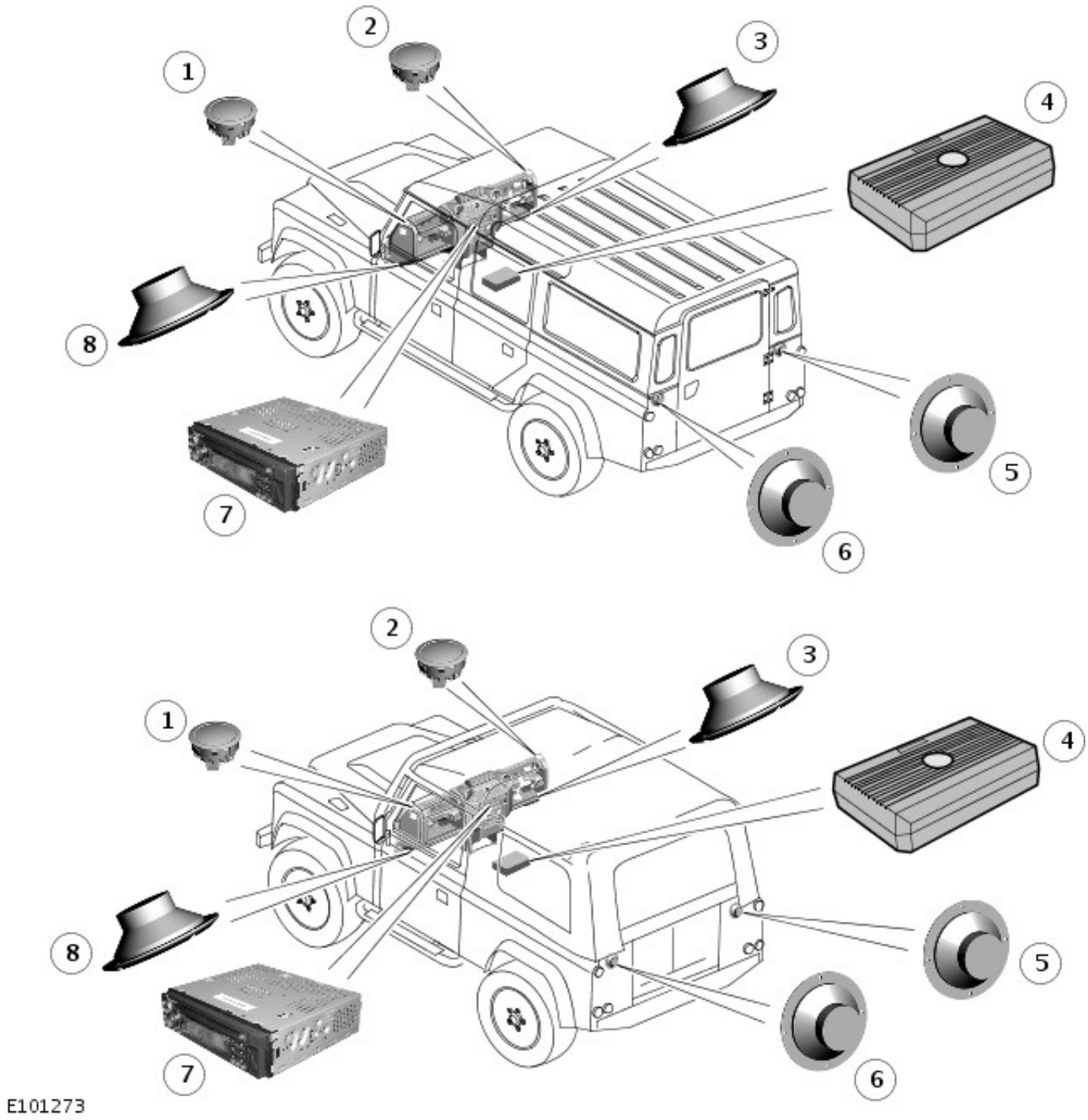
COMPONENT LOCATION - MODELS FROM 2007MY (NOT SVX (60TH ANNIVERSARY) MODEL)



E86512

Item	Part Number	Description
1	-	Front left-hand (LH) high range speaker
2	-	Front right-hand (RH) high range speaker
3	-	Front RH mid range speaker
4	-	Rear RH mid range speaker
5	-	Rear LH mid range speaker
6	-	Audio head unit
7	-	Front LH mid range speaker

COMPONENT LOCATION - SVX (60TH ANNIVERSARY) MODEL



Item	Part Number	Description
1	-	Front LH high range speaker
2	-	Front RH high range speaker
3	-	Front RH mid range speaker
4	-	Sub-woofer
5	-	Rear RH mid range speaker
6	-	Rear LH mid range speaker
7	-	Audio head unit
8	-	Front LH mid range speaker

OVERVIEW

The audio system comprises a CD tuner unit which directly drives up to 6 speakers. The audio head unit is located in the center of the instrument panel. The head unit combines the following functions:

- AM/FM radio
- Audio CD player
- MP3 CD player
- RDS traffic information receiver

The audio system has no diagnostic capabilities and is not connected to any of the vehicles other systems.

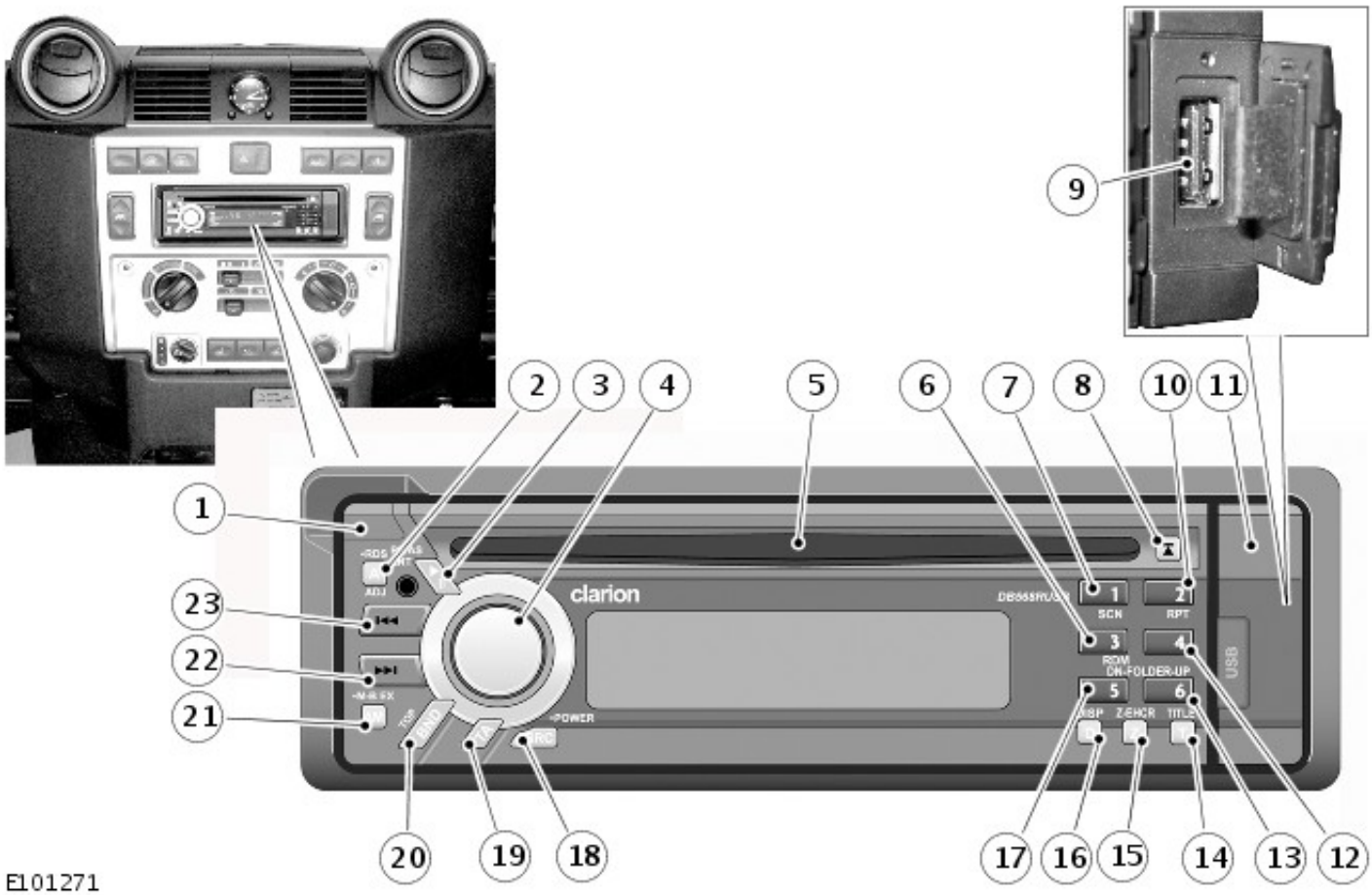
SVX (60th Anniversary) Model

The SVX model has an upgraded head unit, speakers and also a sub-woofer. The head unit has the addition of a universal serial bus (USB) port and is also MP3/WMA compatible.

The 90 model also has two additional speakers located in the rear of the load space.

DESCRIPTION - SVX (60TH ANNIVERSARY) MODEL

Clarion® Head Unit DB568RUSB



Item	Part Number	Description
1	-	Detachable control panel release button
2	-	Auto Frequency (AF) button
3	-	Pre-set scan button/autostore - radio mode or play/pause a track - compact disc (CD)/MP3/WMA/USB mode
4	-	Volume rotary control and function select
5	-	CD insertion/eject slot
6	-	Station pre-set/store 3 button - radio mode or Random play (RDM) button- CD/MP3/WMA/USB mode
7	-	Station pre-set/store 1 button - radio mode or Scan (SCN) button- CD/MP3/WMA/USB mode
8	-	CD eject button
9	-	USB port
10	-	Station pre-set/store 2 button - radio mode or repeat play button - CD/MP3/WMA/USB mode
11	-	USB port cover
12	-	Station pre-set/store 4 button - radio mode
13	-	Station pre-set/store 6 button or select folder up (UP) button for MP3/WMA/USB folder options and for CD-DA or MP3/WMA selection with a multi-session disc
14	-	Title display - MP3/WMA/USB mode
15	-	'Z' sound enhancer button
16	-	Display change button
17	-	Station pre-set/store 5 button or select folder down (DN) button for MP3/WMA/USB folder options and for CD-DA or MP3/WMA selection with a multi-session disc
18	-	Power on/off and mode select button
19	-	Traffic announcement button
20	-	Switch band/seek tuning/manual tuning - radio mode or play first track - CD/MP3/WMA/USB mode
21	-	Audio mode (bass/treble/balance/fade) or Magna-bass selection mode

22	-	Select station - radio mode or select track forwards - CD/USB mode or fast forward - CD/USB mode
23	-	Select station - radio mode or select track backwards - CD/USB mode or fast reverse - CD/USB mode

The head unit is located in a central position in the instrument panel, above the heater controls. The head unit locates in an ISO standard radio cage which is specific to the Clarion® head unit. Two special tools are required to remove the head unit from the cage once installed.

A link harness is used to connect the Clarion® head unit to the existing In-Car Entertainment (ICE) harness connectors. The link harness plugs into the existing ICE connector on the main harness and has four phono plugs and one connector to provide the connections to the Clarion® head unit. The phono plugs provide the speaker outputs and are colored red and white. Two of the plug wires have a blue tracer for identification. Two phono plugs connect to the top 2 phono sockets in the head unit and the two phono plugs with the blue tracer connect to the center 2 phono sockets on the head unit. The phono sockets on the head unit are also colored red and white to ensure the correct connections are made and the speaker polarity is correct. The connector also plugs into the rear of the head unit. The aerial plug is a male plug which connects into a socket on the rear of the head unit.

If iPod connectivity is installed an additional iPod audio connectivity module and link harness is used. The audio connectivity module is located on the cross car beam to the right of the head unit and is secured with a zip tie. This harness plugs into the existing ICE connector and the head unit link harness connects to the iPod audio connectivity module link harness. The audio connectivity module has a lead for the antenna connection. The lead from the antenna is plugged into the module antenna connection and the antenna lead from the module then connects into the head unit antenna connector.

The Clarion® DB568RUSB head unit features a detachable control panel which can be removed for security. The panel is released by pressing the button at the top LH corner of the unit. The panel will be released and can be removed and stored in the supplied case. The panel can be refitted by locating the RH end of the panel in the slots in the head unit and gently pushing the LH end of the panel towards the unit until the catch engages.

A USB port is located in the RH hand end of the unit and can be accessed by opening a cover on the detachable control panel. The port allows the use of a customer supplied USB memory device to allow access to a large range of music files in both MP3 and WMA formats. The unit can read the files and folder structures and data from the memory device and play the music directly via the USB port. It is not recommended to use this port for iPod connection.

Full operating instructions and unit features are detailed in the owner literature supplied with the vehicle.

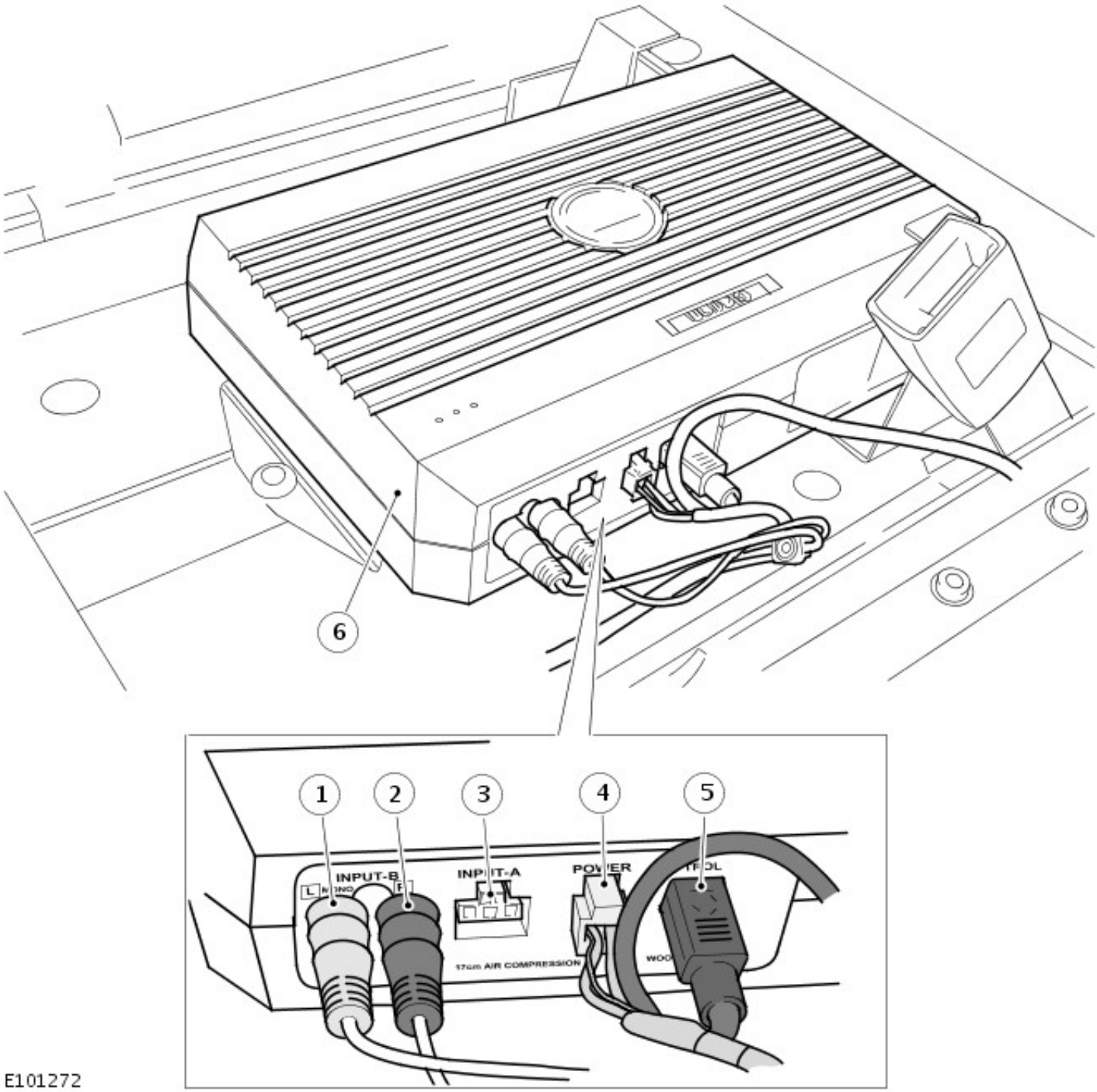
An auxiliary input socket is located inside the cubby box. The socket allows for the additional connection of an MP3 player or other storage device via a single pin jack plug.

Specifications

- Power supply voltage: 14.4 Volts (10.8 to 15.6 Volts allowable) - Negative earth
- Current consumption: less than 15 Amperes
- Speaker impedance: 4 Ohms (4 to 8 Ohms allowable)
- Audio maximum power output: 200 Watts (50 Watts X 4 channels)
- Audio power output: 4 X 25 Watts
- USB 1.1 and 2.0 compatible with transfer rate of 12 Mbps maximum
- MP3 and WMA compatible
- FM frequency range: 87.5 to 108 MHz
- MW frequency range: 531 to 1602 kHz
- AM frequency range: 153 to 279 kHz

The speakers installed in the SVX vehicle are upgraded from the standard fitment and are also supplied by Clarion®. These speakers are connected to the existing speaker harnesses by link leads which allow for the different connector specifications required for the Clarion® speakers.

Clarion Sub-Woofer SRV313

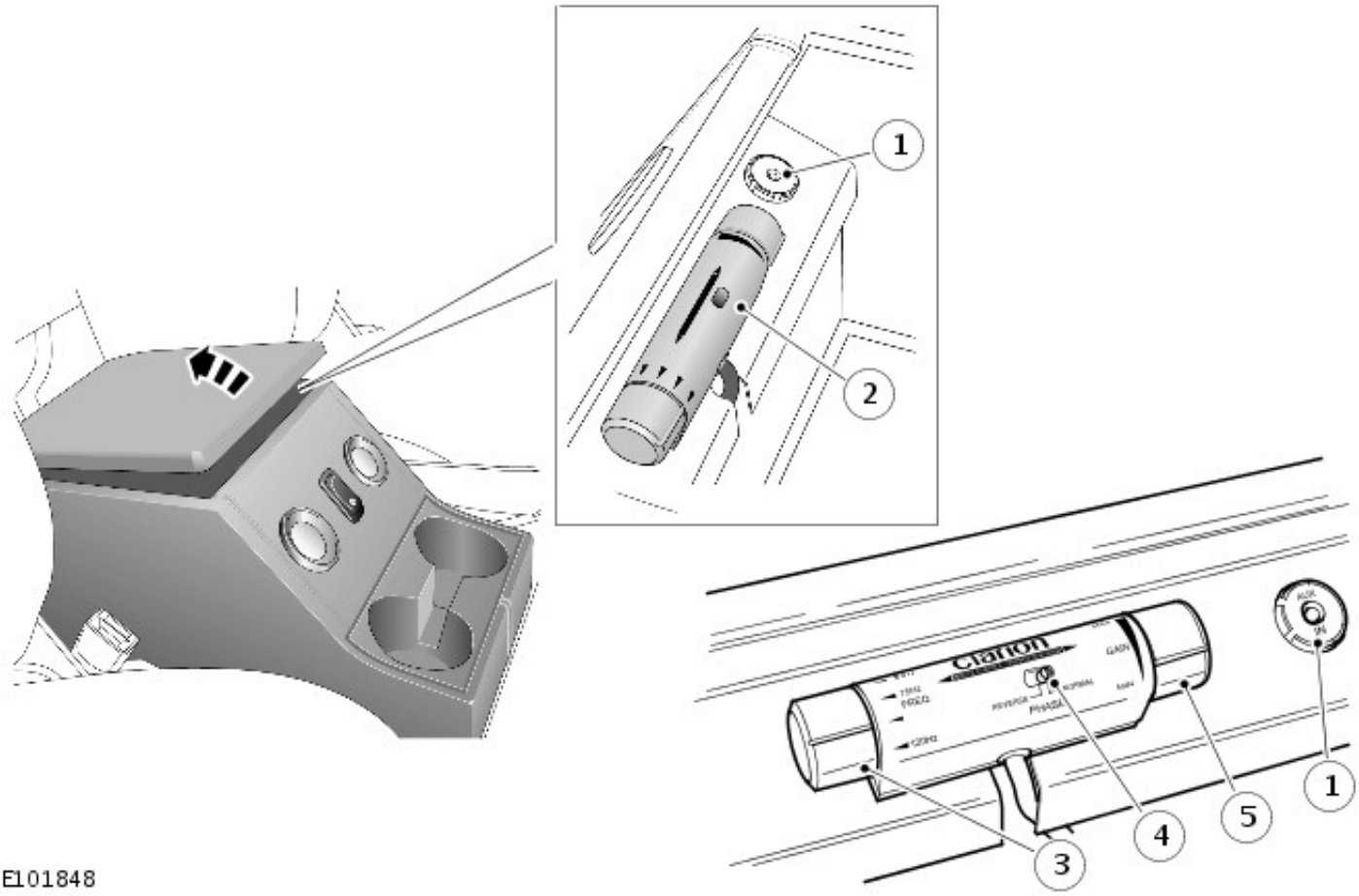


Item	Part Number	Description
1	-	LH phono plug speaker input
2	-	RH phono plug speaker input
3	-	Not used
4	-	Power and ground connector
5	-	Remote control connector
6	-	Sub-woofer unit

The Clarion® SRV313 sub-woofer is located on the cabin floor below the center cubby box and is secured to the floor with two self-tapping screws.

The sub-woofer is connected to the head unit via a link cable from the head unit. Two phono plugs provide speaker inputs for LH and RH inputs and are colored white and red respectively for identification and connect into the 'Input B' sockets (the 'Input A' socket is not used). A power supply socket provides power and ground for unit power. A 'Remote Control' socket allows for the connection of the remote control unit.

Remote Control and Auxiliary Socket



Item	Part Number	Description
1	-	Auxiliary socket
2	-	Remote control
3	-	Frequency control
4	-	Phase switch
5	-	Gain volume control

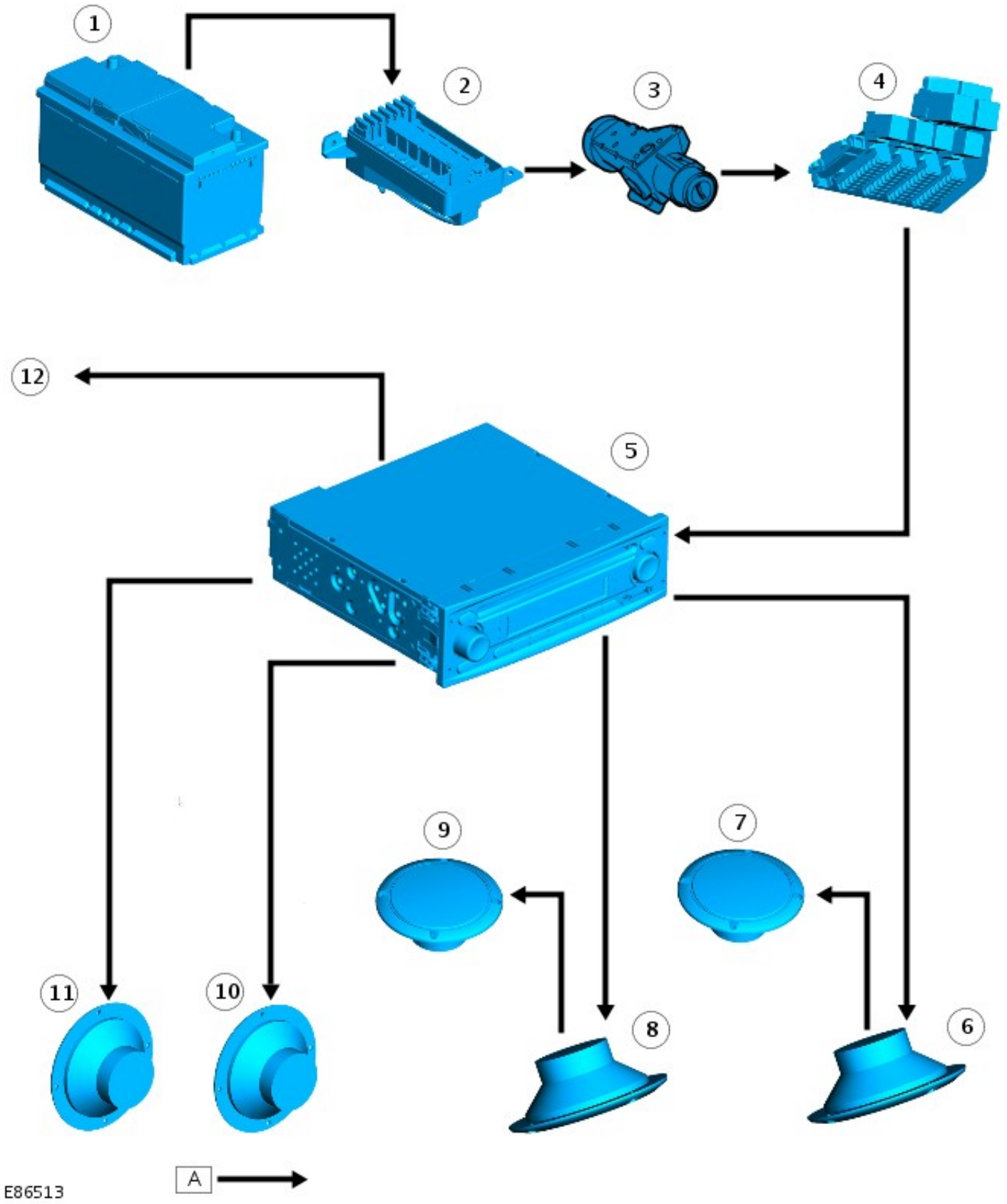
The remote control unit is located in the front of the cubby box and is accessible by lifting the cubby box lid. The remote control has a rotary control on the LH end which allows for adjustment of the sub-woofer bass output by adjusting the cut-off frequency of the low-pass filter. Four selections are available; 50/75/100 and 120 Hz. The sub-woofer will only output frequencies below the selected Hz level. The rotary control on the RH end of the remote control provides for adjustment of the speaker 'gain' and can be used to adjust the sub-woofer volume output, independent of the head unit volume control. A switch on the remote control allows for the sub-woofer phase to be switched between normal and reverse. Clarion recommend for this application the setting is the 'normal' phase.

An auxiliary input socket is located adjacent to the remote control. The socket allows for the connection of an additional auxiliary audio input, an MP3 player for example.

Sub-Woofer Specifications

- 120 Watt high power amplifier with low pass filter
- 17 cm counter drive woofer with dualneodymium magnet
- Air compression structure with die-cast aluminum enclosure
- Wired remote control for gain control/low pass filter (selectable 50/75/100/120 Hz) /phase filter
- Dual 4 Ohm voice coils.

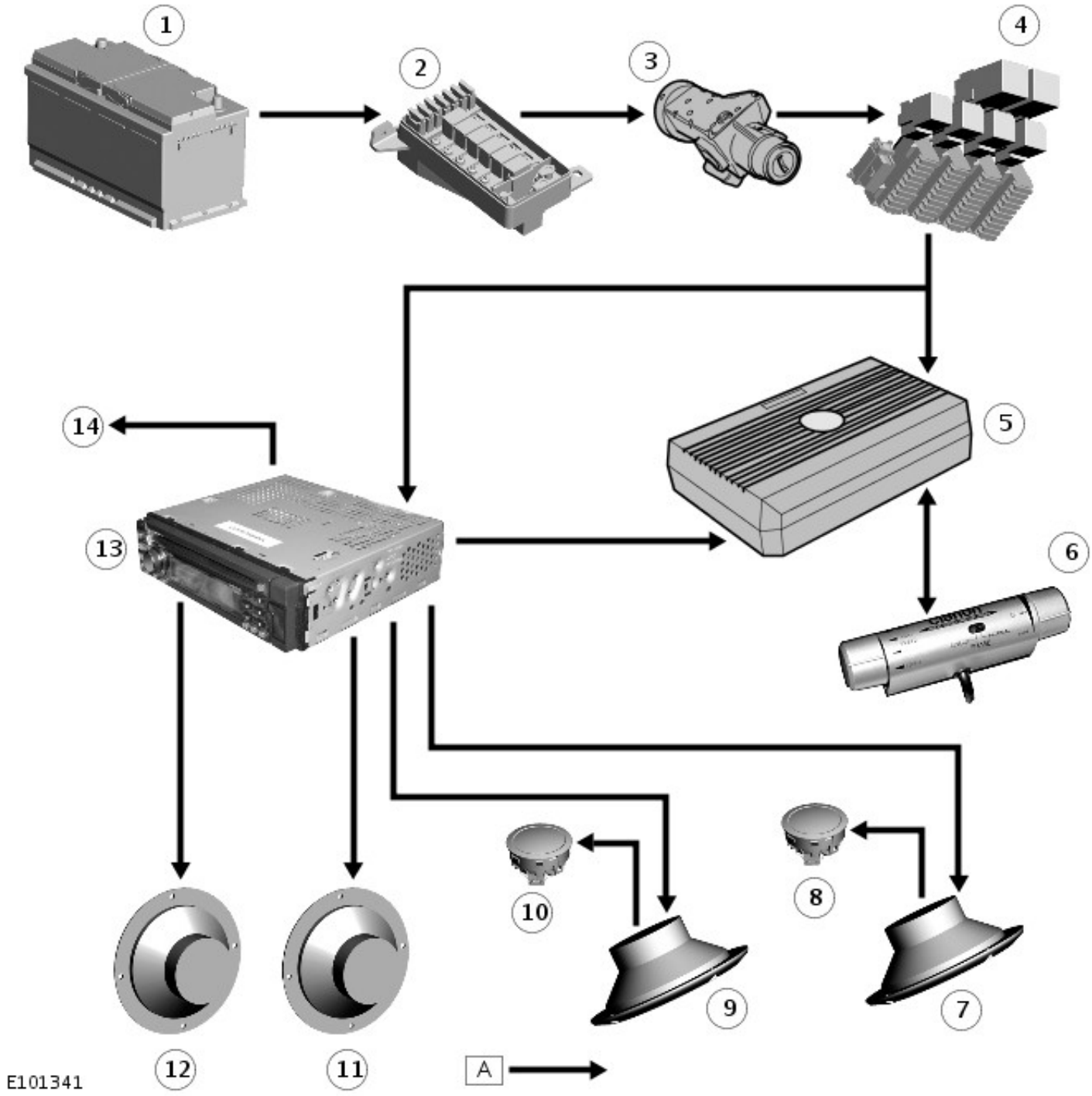
CONTROL DIAGRAM - MODELS FROM 2007MY (NOT SVX (60TH ANNIVERSARY) MODEL)



Item	Part Number	Description
1	-	Battery
2	-	battery junction box (BJB)
3	-	Ignition switch
4	-	central junction box (CJB)
5	-	Audio head unit
6	-	Front RH mid range speaker

7	-	Front RH high range speaker
8	-	Front LH mid range speaker
9	-	Front LH high range speaker
10	-	Rear RH mid range speaker
11	-	Rear LH mid range speaker
12	-	Antenna

CONTROL DIAGRAM - SVX (60TH ANNIVERSARY) MODEL

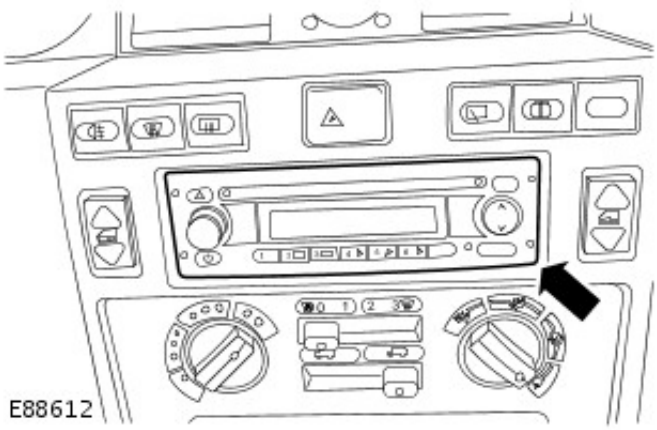


Item	Part Number	Description
1	-	Battery
2	-	BJB
3	-	Ignition switch
4	-	CJB
5	-	Sub-woofer
6	-	Sub-woofer remote control
7	-	Front RH mid range speaker
8	-	Front RH high range speaker
9	-	Front LH mid range speaker
10	-	Front LH high range speaker

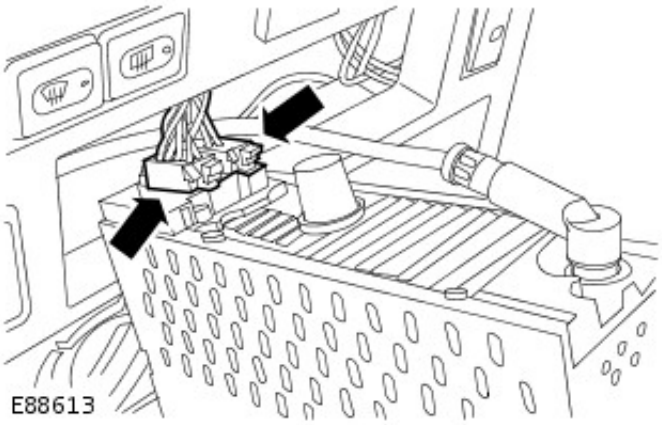
11	-	Rear RH mid range speaker
12	-	Rear LH mid range speaker
13	-	Audio head unit
14	-	Antenna

Audio Unit - Audio Unit
Removal and Installation

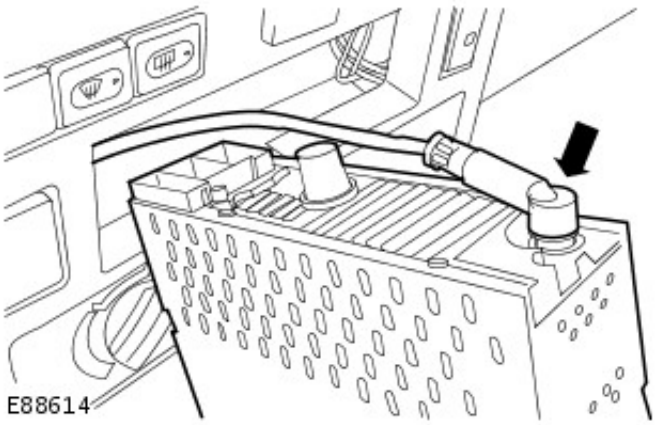
Removal



1. Using the audio unit removal tools, release the audio unit.



2. Disconnect the 2 electrical connectors from the audio unit.



3. Remove the audio unit.

- Disconnect the antenna cable.

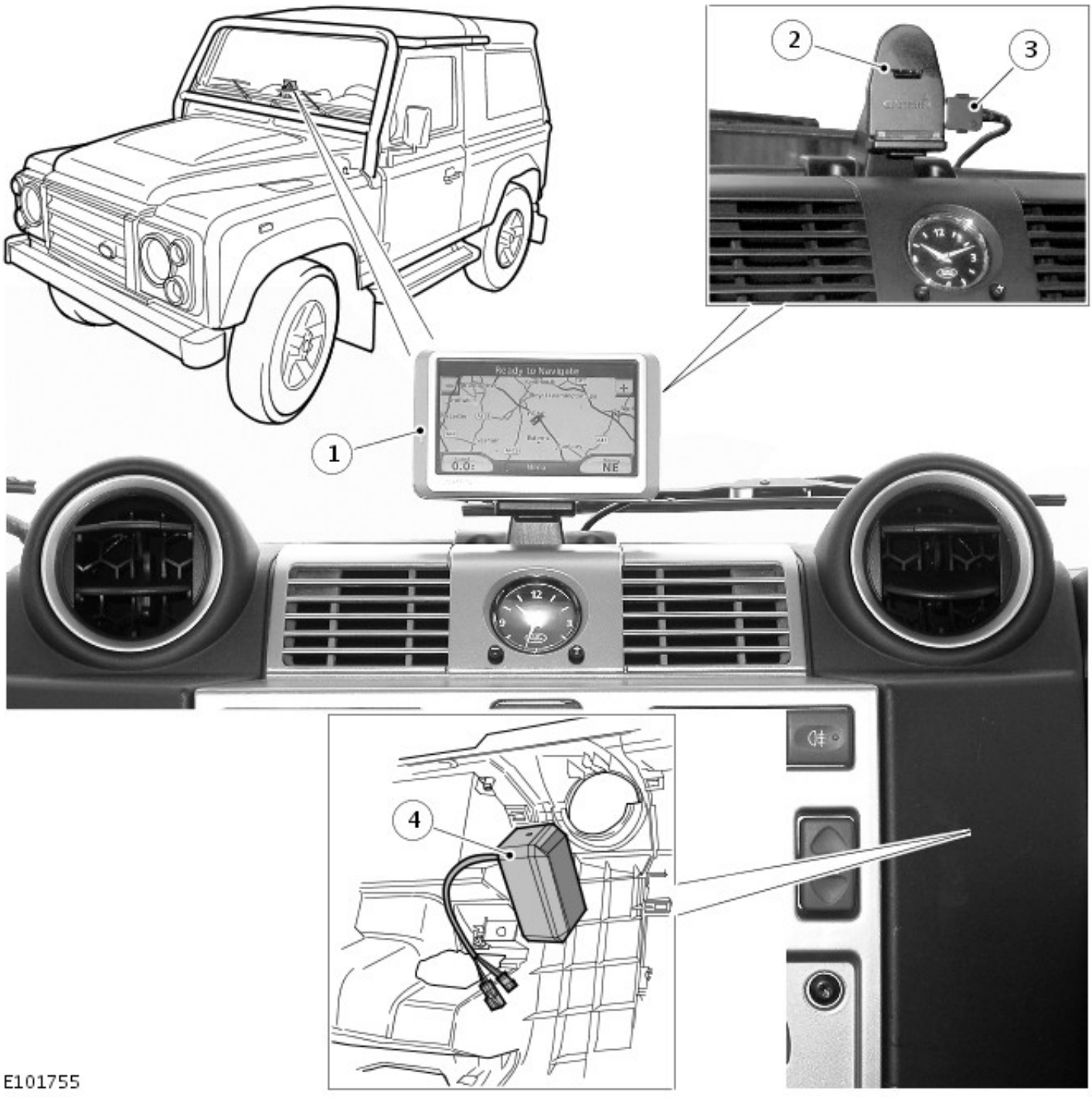
Installation

1. To install, reverse the removal procedure.

Information and Entertainment System - Navigation System

Description and Operation

COMPONENT LOCATION - SVX (60th ANNIVERSARY) MODEL



Item	Part Number	Description
1	-	Personal Travel Assistant navigation unit
2	-	Cradle
3	-	Electrical connector
4	-	External speaker (located behind instrument panel)

OVERVIEW

The satellite navigation system is a standard fitment on the SVX model and is available as an accessory fitment on other models. The unit is known as the 'Land Rover Personal Travel Assistant' and its use and operation is covered in a separate instruction book supplied with the vehicle.

The Personal Travel Assistant provides a comprehensive navigation system, which assists the driver by providing a route to a selected destination. The map and turn information which is displayed on the touch screen is supplemented by voice guidance.

The Personal Travel Assistant is also equipped with additional features, which can be accessed via the Tools menu:

- media player
- picture viewer
- calculator
- language guide
- currency converter
- unit converter.

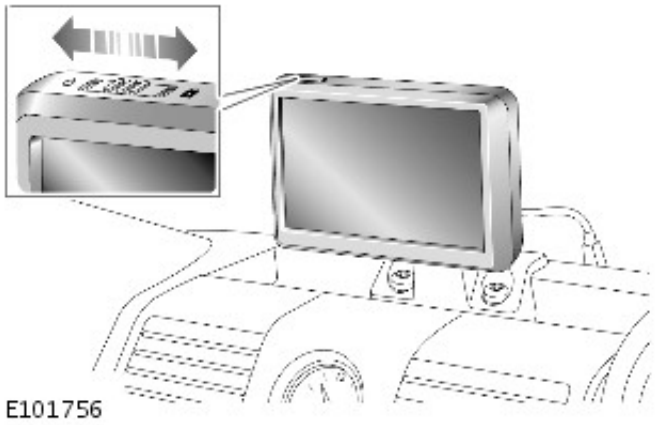
WARNING: In the interests of road safety, only operate, adjust or view the system when it is safe to do so.

The Personal Travel Assistant must be able to locate satellite signals in order to operate. The strength of these signals can vary depending on the location. Near tall buildings or trees, the signal strength may be affected. When a strong signal is being received, the bars at the top left of the main menu are green, when the signal deteriorates, the bars turn red or become clear with a red 'x' appearing on the bars.

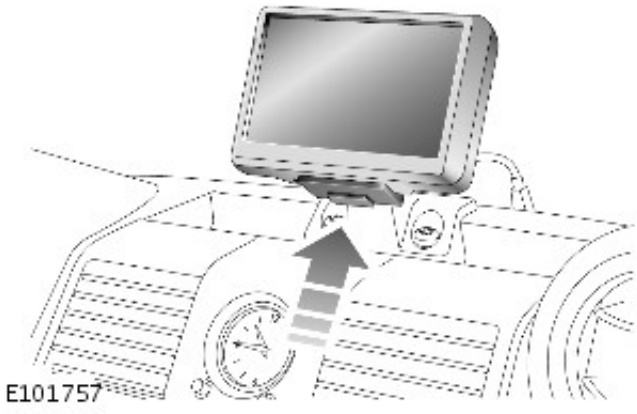
DESCRIPTION

On the SVX model, the satellite navigation unit is a 'Garmin™' manufactured unit with Land Rover specific software installed. The unit is self-contained with its own internal battery. The vehicle wiring harness connections provide for connection to the external speaker and the power supply for internal battery charging and powering the unit while it is connected to the vehicle.

The unit uses a remote external speaker for the voice and audio output. The speaker is located below the driver's side center air vent, behind the instrument panel. The unit however, also has its own internal speaker allowing the unit to be used when not in the vehicle.

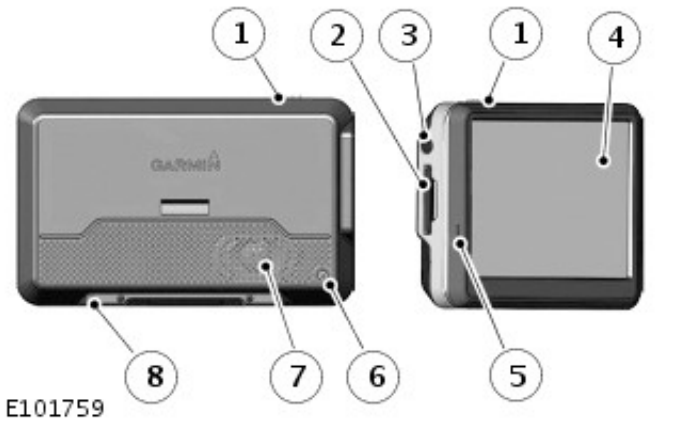


The unit can be switched on using a spring loaded switch on the top of the unit. To switch the unit on, push the switch to the left. To subsequently switch the unit off, push the switch to the left a second time. The unit can be locked to prevent inadvertent operation by sliding the switch on the top of the unit to the right.



The satellite navigation unit is mounted on a bracket which is secured to the top of the instrument panel with 2 bolts. The bracket houses a cradle with a connector which allows the unit to be secured into position and also connected electrically to the vehicle electrical system and the navigation speaker. The cradle is mounted on a ball which allows the unit to be adjusted vertically and horizontally so that it can be moved to face the passenger or driver's seat positions. The unit clips into position on the bracket and can be released by pressing a release catch on the bottom of the cradle, tilting the top of the unit forwards and removing the unit from the cradle.

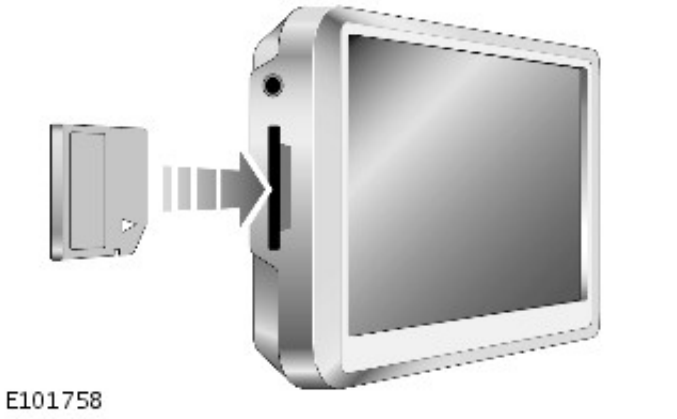
Garmin™ Nuvi 750 Unit Details



Item	Part Number	Description
1	-	On/Off/Lock switch
2	-	SD card slot
3	-	Earphone/audio out jack plug
4	-	liquid crystal display (LCD)
5	-	Microphone (not used)
6	-	External antenna connector
7	-	Internal speaker
8	-	universal serial bus (USB) connector

The Personal Travel Assistant uses a wide-screen, LCD with a white backlight and touch screen functionality. The screen has a 480 X 272 pixel display.

On the left-hand (LH) end of the unit a 3.5 mm jack plug allows for the connection of audio headphones. A slot, below the jack plug, provides for the insertion of an SD memory card. The card can be used to store music and pictures which can be played and displayed on the unit. The unit can play MP3, MP3U and MP3U8 playlist files, display pictures in JPEG format and play audio books in AA format.



On the underside of the unit are two plugs. The larger, centrally positioned, plug mates with a similar plug in the cradle and connects the unit to the vehicle electrical system. The smaller plug provides for the connection of a USB cable to allow the unit to be connected to a computer to allow software upgrades to be installed.

The unit contains an integral lithium-ion battery which cannot be replaced. A battery icon is displayed in the LCD and indicates the status of the internal battery. If the unit is to be discarded, it must be disposed of according to local regulations. The battery, once fully charged has a battery charge time of between 3 and 7 hours, depending on unit usage.

Trouble Shooting

Problem	Solution
Unable to receive satellite signals	Ensure the unit is not in an enclosed garage or car park and away from tall buildings and trees. Remain stationary for several minutes to allow the unit to establish satellite connection.
The unit will not charge in the vehicle	The unit will only charge if the temperature is between 0 and 45°C (32 and 113°F). At temperatures above or below this range or if the unit is placed in direct sunlight or in a hot environment, the battery will not charge.
How to clear all user data	Hold finger on lower right-hand (RH) corner of touch screen and turn the unit on. Continue to press corner of touch screen until message appears. Touch 'Yes' to clear all user data.
The unit is locked up or frozen	If the touch screen stops functioning, turn the unit off and then on again. If this does not correct the problem, slide the power on/off switch to the left and hold for 8 seconds. The unit will switch off. Switch the unit back on again and it will operate normally.

Touch screen is not responding to touch	Turn the unit off and then back on again. Slide the on/off switch to the right (lock position). Hold a finger on the touch screen for approximately 30 seconds until the calibration screen appears. Follow the on-screen instruction.
The battery gauge seems inaccurate	Allow the unit to fully discharge. Then, fully charge the unit without disrupting the charge cycle.

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Speakers - Speakers

Description and Operation

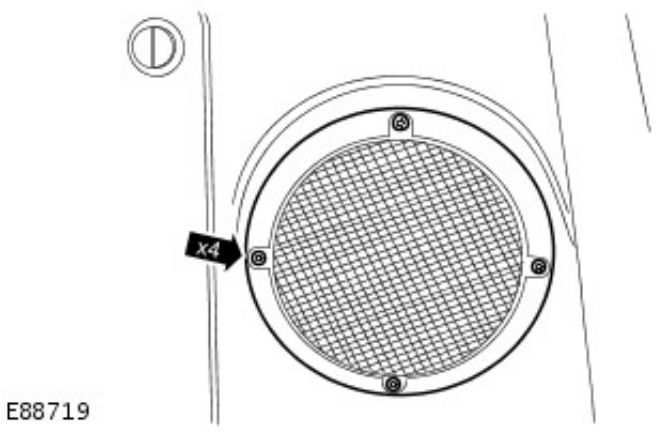
OVERVIEW

For additional information, refer to: Audio System (415-01A Audio Unit, Description and Operation).

Speakers - Instrument Panel Speaker

Removal and Installation

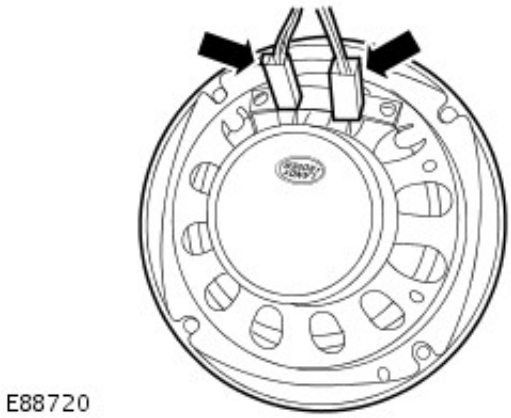
Removal



1. NOTE: RH shown, LH similar.

Release the instrument panel speaker.

- Remove the 4 screws.



2. Remove the instrument panel speaker.

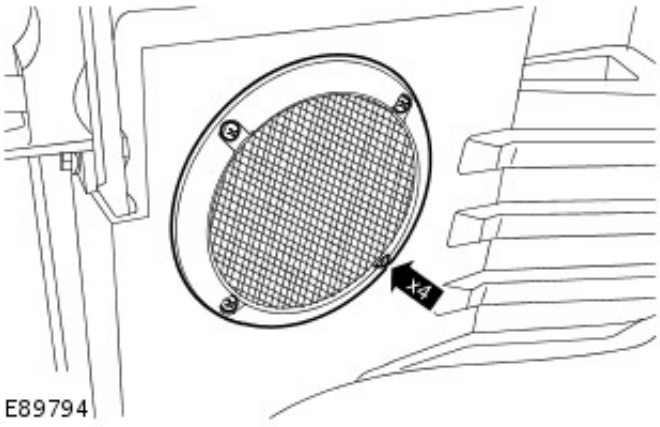
- Disconnect the 2 electrical connectors.

Installation

1. To install, reverse the removal procedure.

Speakers - D-Pillar Speaker
Removal and Installation

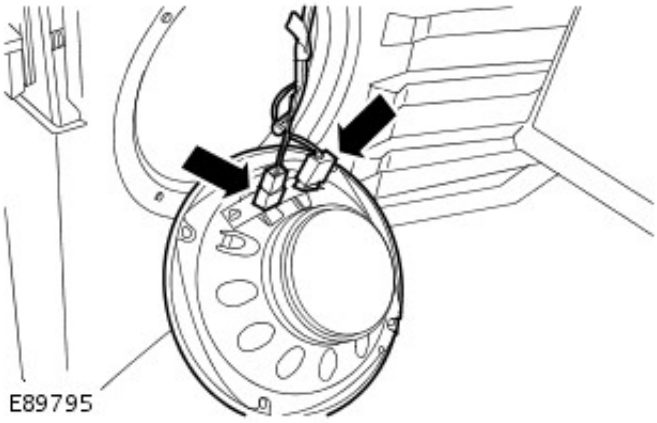
Removal



1. NOTE: LH shown, RH similar.

Release the speaker.

- Remove the 4 screws.



2. Remove the speaker.

- Disconnect the 2 electrical connectors.

Installation

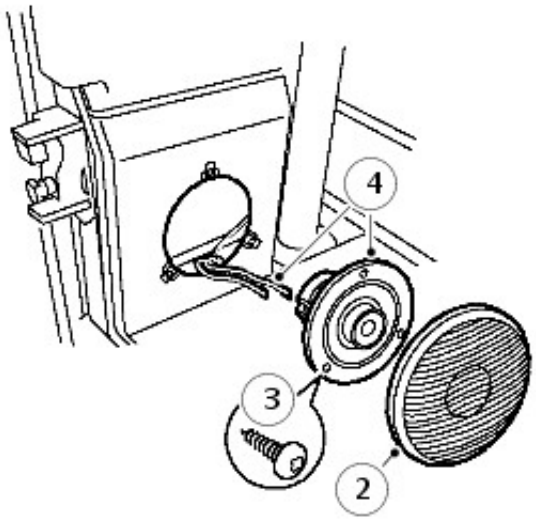
1. To install, reverse the removal procedure.

Speakers - Rear Door Speaker

Removal and Installation

Removal

1. Raise rear seat cushion and fit stowage strap.
2. Carefully prise grille from speaker.
3. Remove 3 screws and withdraw speaker from trim panel.
4. Disconnect 2 electrical leads and remove speaker.



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Installation

1. Connect 2 electrical leads, position speaker and secure with screws.
2. Position grille and press firmly to secure.

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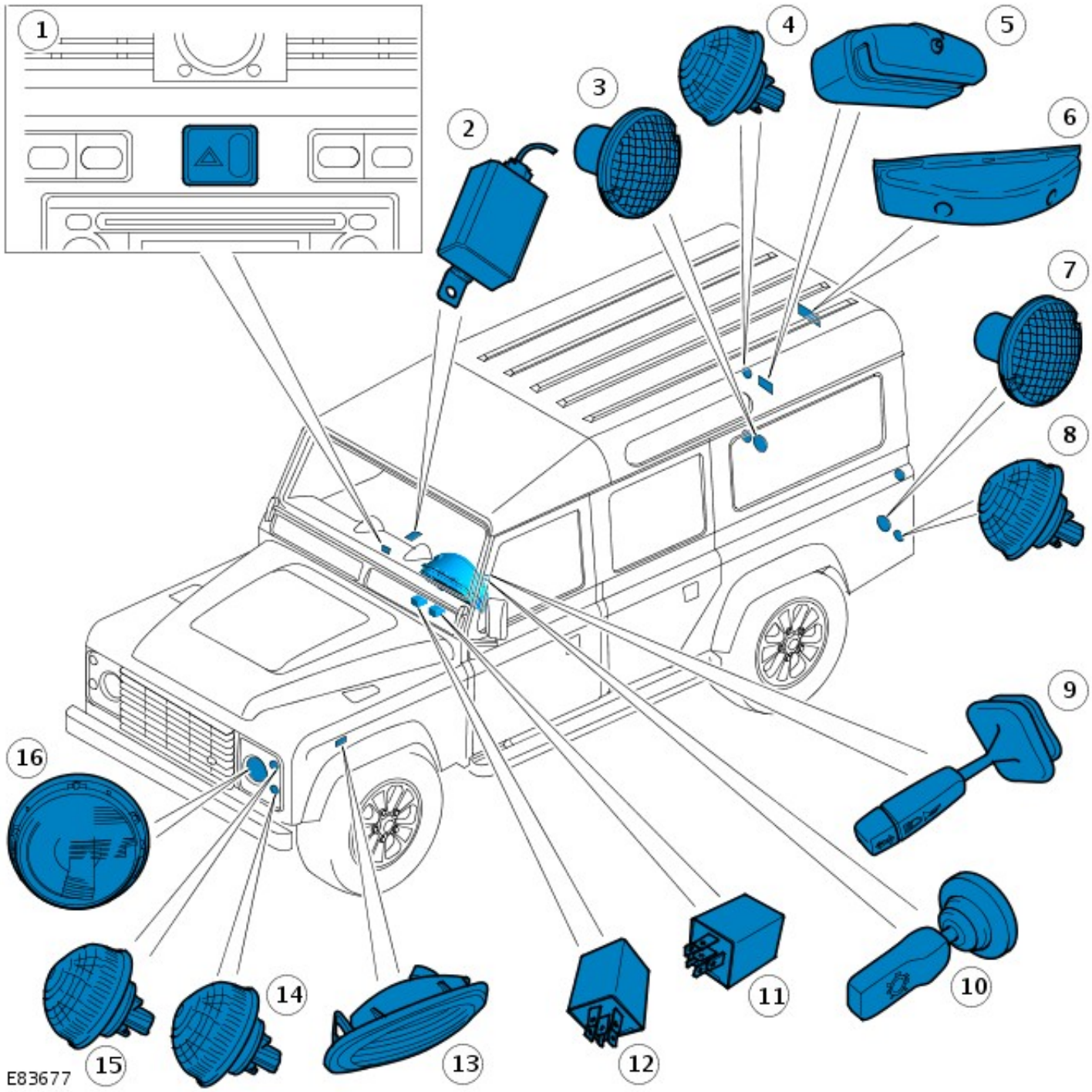
Exterior Lighting - Exterior Lighting

Description and Operation

COMPONENT LOCATION - MODELS FROM 2007MY (NOT SVX (60TH ANNIVERSARY) MODEL)

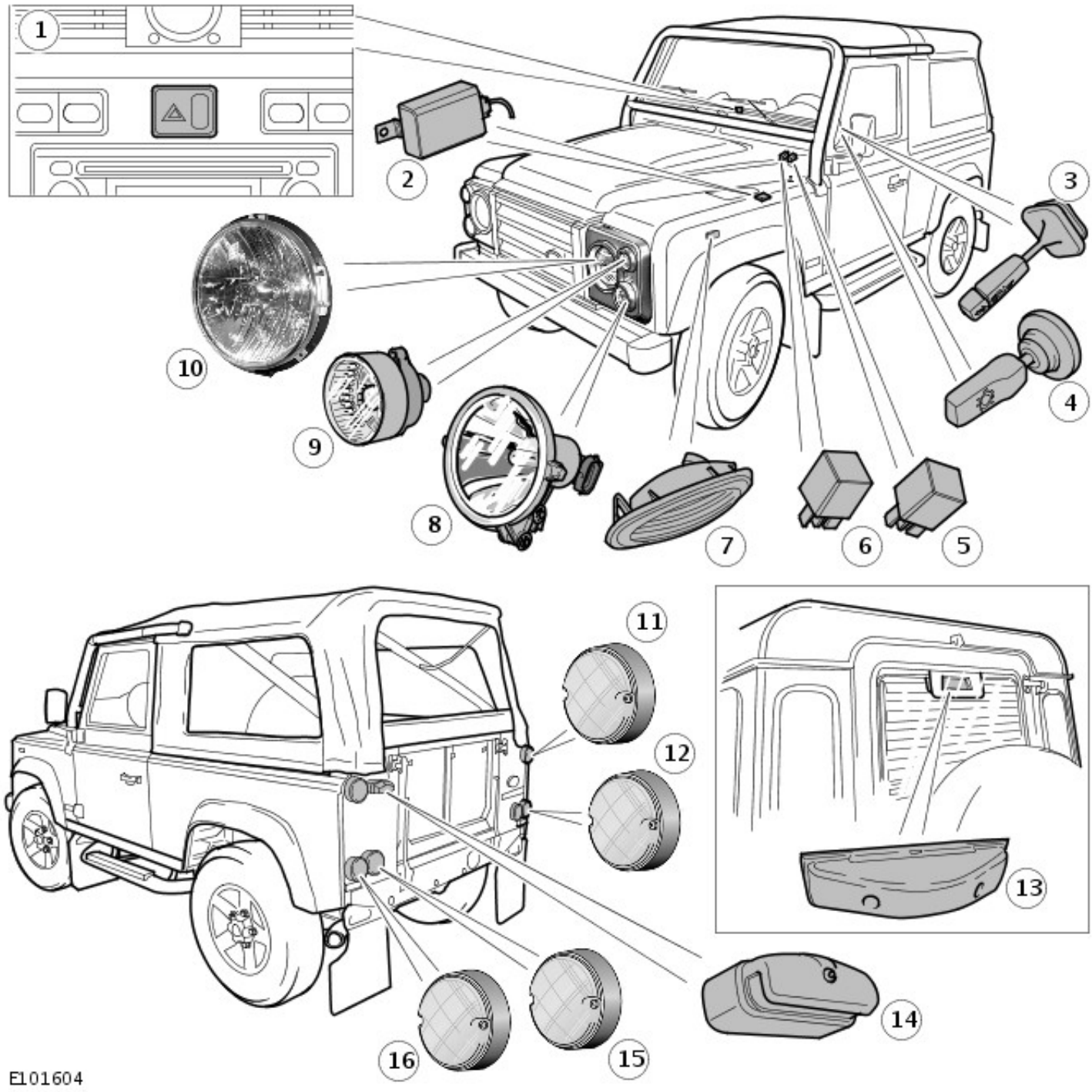


Item	Part Number	Description
1	-	Hazard flasher switch
2	-	Fog lamp control module
3	-	Rear fog lamp
4	-	Rear tail/Stop lamp
5	-	License plate lamp
6	-	High mounted stop lamp
7	-	Reverse lamp
8	-	Rear turn signal indicator lamp
9	-	Steering column multifunction switch
10	-	Lighting control switch
11	-	Headlamp relay
12	-	Hazard flasher relay
13	-	Side turn signal indicator lamp

14	-	Front turn signal indicator lamp
15	-	Side lamp
16	-	Headlamp

COMPONENT LOCATION - SVX (60TH ANNIVERSARY) MODEL

• NOTE: 90 model shown, 110 model similar



Item	Part Number	Description
1	-	Hazard flasher switch
2	-	Fog lamp control module
3	-	Steering column multifunction switch
4	-	Lighting control switch
5	-	Headlamp relay
6	-	Hazard flasher relay
7	-	Side turn signal indicator lamp (2 off)
8	-	Auxiliary high beam lamp (2 off)
9	-	Front turn signal indicator lamp (2 off)
10	-	Headlamp - incorporating integral side lamp
11	-	Rear tail/Stop lamp (2 off)

12	-	Rear fog lamp or reverse lamp (depending on market)
13	-	High mounted stop lamp (Not 90 models)
14	-	Licence plate lamp
15	-	Rear fog lamp or reverse lamp (depending on market)
16	-	Rear turn signal indicator lamp (2 off)

OVERVIEW

Operation of the exterior lamps is controlled via the lighting control switch and the steering column multifunction switch. The lighting control switch is a 3 way switch mounted on the left-hand (LH) side of the steering column. When pushed forward to the first position the switch will provide a battery feed to the side lamps, tail lamps and number plate lamps irrespective of ignition switch position. When pushed forward to the second position, the lighting control switch will also provide a feed to the headlamp relay.

The steering column multifunction switch is mounted forward of the lighting control switch on the LH side of the steering column and allows the driver to switch between headlamp high beam, low beam and flash operation. The steering column multifunction switch is provided a feed by the headlamp relay, which becomes energized when the ignition switch is turned to position II.

Where fitted, a 4 position rotary headlamp leveling switch is mounted on the instrument panel to allow the driver to raise or lower headlamp alignment according to the load being carried in the vehicle. A motor mounted on the rear of each headlamp adjusts the alignment of the headlamps in response to movements in switch position.

Operation of the turn signal indicator lamps is also controlled using the steering column multifunction switch. The steering column multifunction switch is provided an ignition switch feed from the hazard flasher relay. When the switch is moved to the left or right turn position, the switch contacts close and a feed is provided to the relevant turn signal indicator lamps. A feed is also provided to the instrument cluster to illuminate the turn signal warning indicator.

The hazard flasher switch is located on the instrument panel and operates the LH and right-hand (RH) turn signal indicator lamps simultaneously when pressed. The hazard flasher switch is provided a constant battery feed and will operate the turn signal indicator lamps irrespective of ignition switch position. When pressed, the hazard flasher switch also provides a feed to the instrument cluster to illuminate the hazard flasher warning indicator.

The stop lamps are controlled by the stop lamp switch, which is mounted on top of the brake pedal. When the brake pedal is pressed the switch contacts close allowing an ignition switch feed to power the stop lamps.

The reverse lamp is controlled by the reverse gear switch, which is mounted on the transmission. When reverse gear is selected the switch contacts close allowing an ignition switch feed to power the reverse lamp.

Operation of the rear fog lamp is controlled by the fog lamp control module, which is located beneath the RH front seat. The control module is provided an ignition switch feed from the energized headlamp relay via the central junction box (CJB). The control module monitors the condition of the fog lamp switch. When the switch is pressed, the switch contacts close and a ground path is created. When the control module registers the ground path it provides a feed to the rear fog lamp and the instrument cluster.

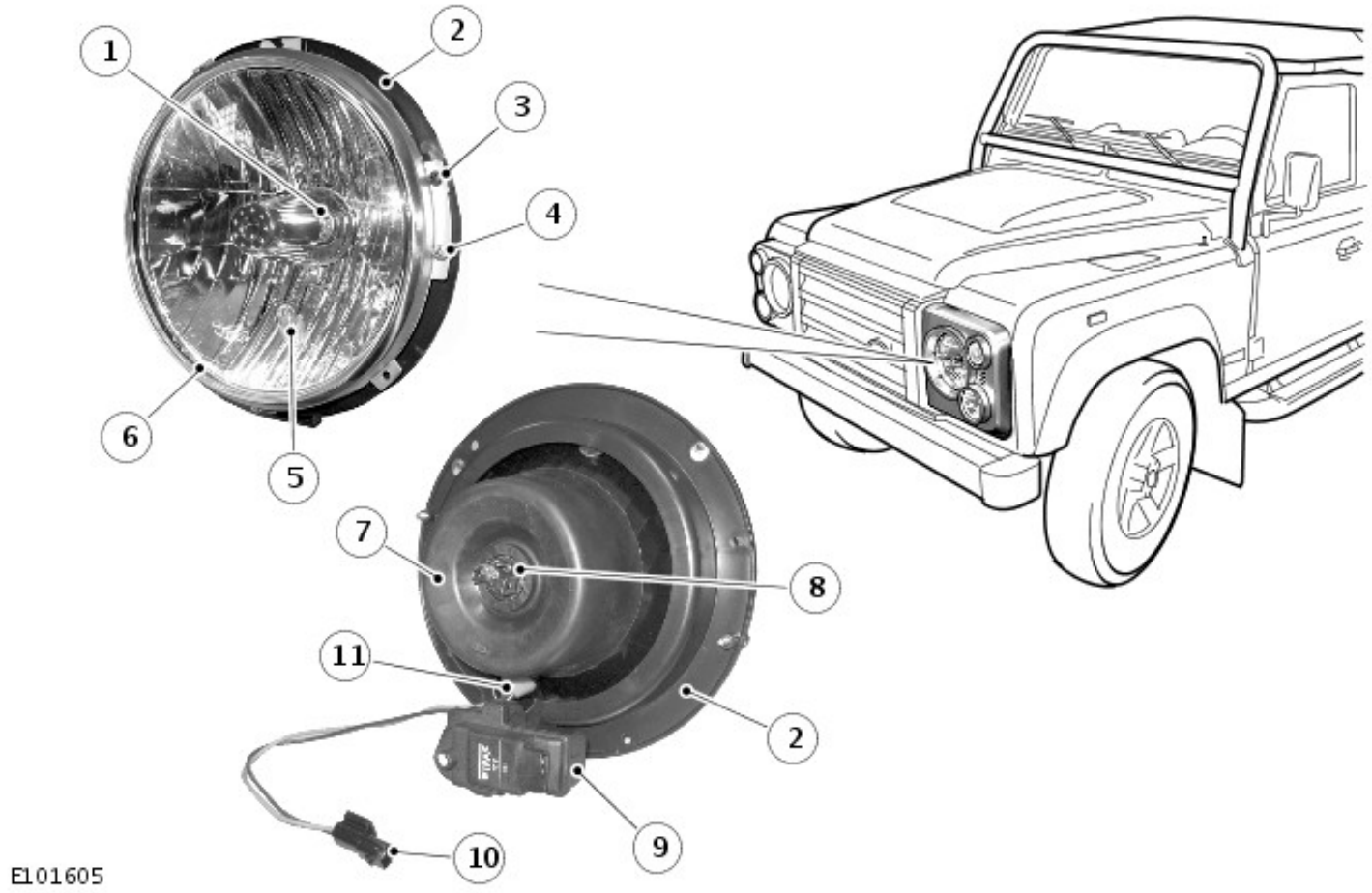
SVX (60th Anniversary) Model

The exterior lighting system on the 2008MY SVX model is as described above with the following differences:

- light emitting diode (LED) rear lights
- halogen headlamps with a complex surface reflector and integral side lamp
- separate high beam driving lamps
- new front turn signal indicator lamps.

DESCRIPTION - SVX (60TH ANNIVERSARY) MODEL

Headlamp



Item	Part Number	Description
1	-	Halogen bulb
2	-	Headlamp mounting
3	-	Headlamp securing screw
4	-	Headlamp beam alignment screw
5	-	Side lamp bulb
6	-	Headlamp assembly
7	-	Rubber cover
8	-	Headlamp bulb connections
9	-	Headlamp adjustment motor (if fitted)
10	-	Side lamp connector
11	-	Side lamp bulb holder

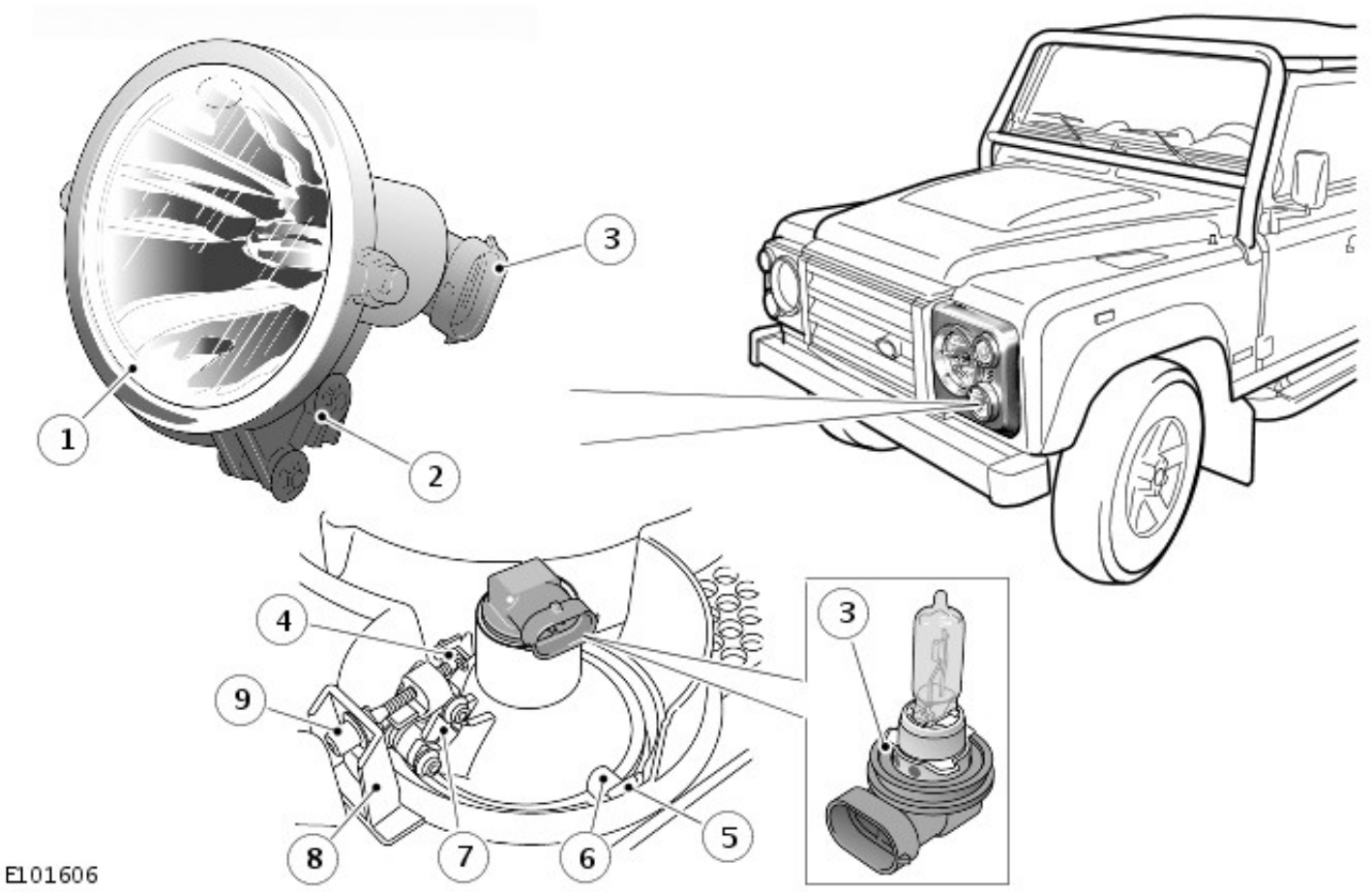
The headlamp is a unique unit to the SVX model. The headlamp is a Wipac unit with a reflector divided into parabolic segments, with each segment having a different focal length. The headlamp uses a H4 60/55W halogen bulb which is retained in the rear of the headlamp with a wire clip. The headlamp also houses the sidelamp which is located in a hole in the headlamp lens. The side lamp uses a W5W bayonet fitting bulb which is located in a rubber holder. A harness connector from the side lamp connects into the existing side lamp connector in the main wiring harness.

The RH headlamp unit is connected into the main wiring harness. The LH headlamp is connected to the main harness via a link harness which also supplies power to the auxiliary driving lamps.

Where fitted, an electric motor mounted on the rear of the headlamp allows for the electrical adjustment of the headlamp alignment.

The headlamp is secured to a metal mounting plate, which is attached to the fender, with 4 self-tapping screws.

Auxiliary High Beam Lamp

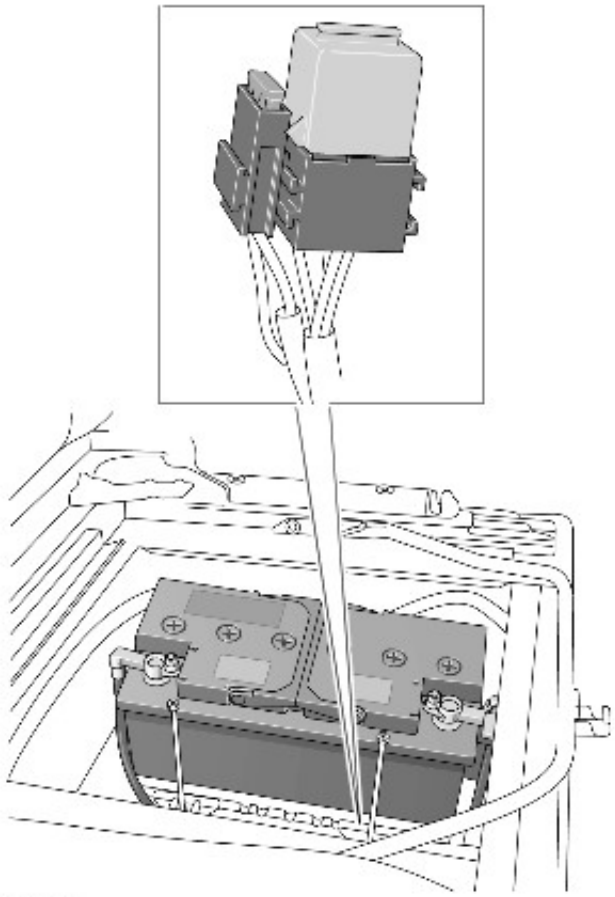


Item	Part Number	Description
1	-	Auxiliary high beam lamp assembly
2	-	Adjustment lever
3	-	Electrical connector and halogen bulb holder
4	-	'R' clip
5	-	Pivot plate (2 off)
6	-	Pivot pin (2 off)
7	-	Pivot lever
8	-	Headlamp surround
9	-	Alignment adjustment screw

The auxiliary high beam lamp is unique to the SVX model. The lamp is located within the headlamp surround. Two metal plates are a press fit into the surround and 2 pivot pins on the lamp locate in the plates which allow the lamp unit to pivot up and down in a vertical direction. This allows the vertical aim of the lamp to be adjusted using a worm and screw mechanism located on the lamp. The adjustment screw locates in a hole on a moulded boss on the headlamp surround. A washer is fitted to the screw on each side of the boss and are secured with circlip. The two washers and the circlip retain the screw in the boss, which allows the rotary motion of the screw to be transferred to linear movement of the lamp allowing the alignment to be adjusted. The screw is accessible through a hole in the underside of the lamp surround.

The auxiliary high beam lamp uses a H9 65W halogen bulb which is located in an integral holder. The holder is rotated to lock or remove in the rear of the lamp unit. Access to the bulb requires removal of the headlamp surround.

Auxiliary High Beam Lamp Relay and Fuse



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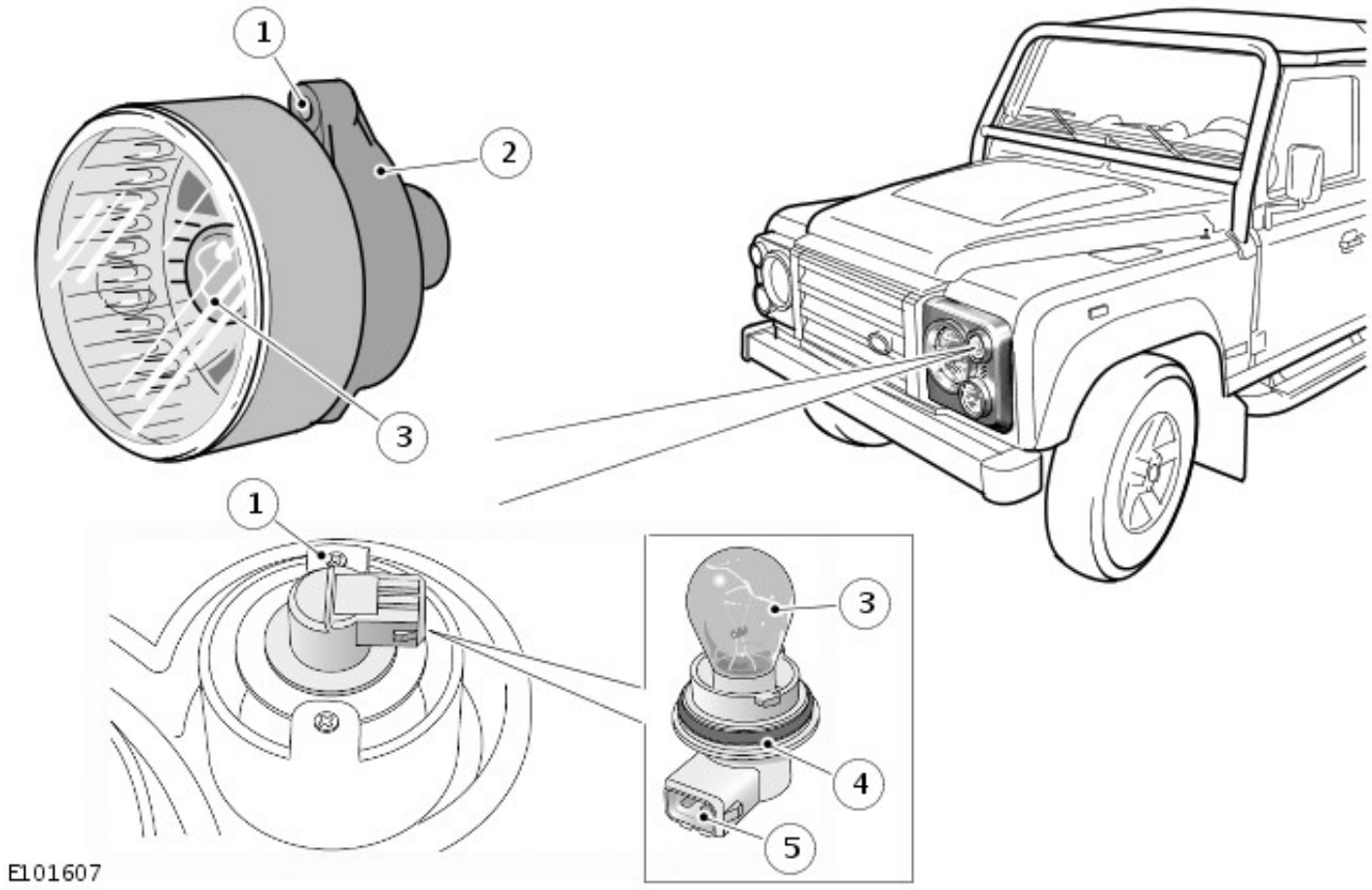
The auxiliary lamps are connected via the headlamp link harness. A high beam feed from the LH headlamp is supplied from the link harness and activates a dedicated auxiliary high beam lamp relay which is located in the battery junction box (BJB), adjacent to the battery. The relay and auxiliary lamp circuit is protected by a 15 Amp fuse located on the side of the relay. Activation of the relay allows a direct battery feed to power the auxiliary lamps.

Front Turn Signal Indicator Lamp

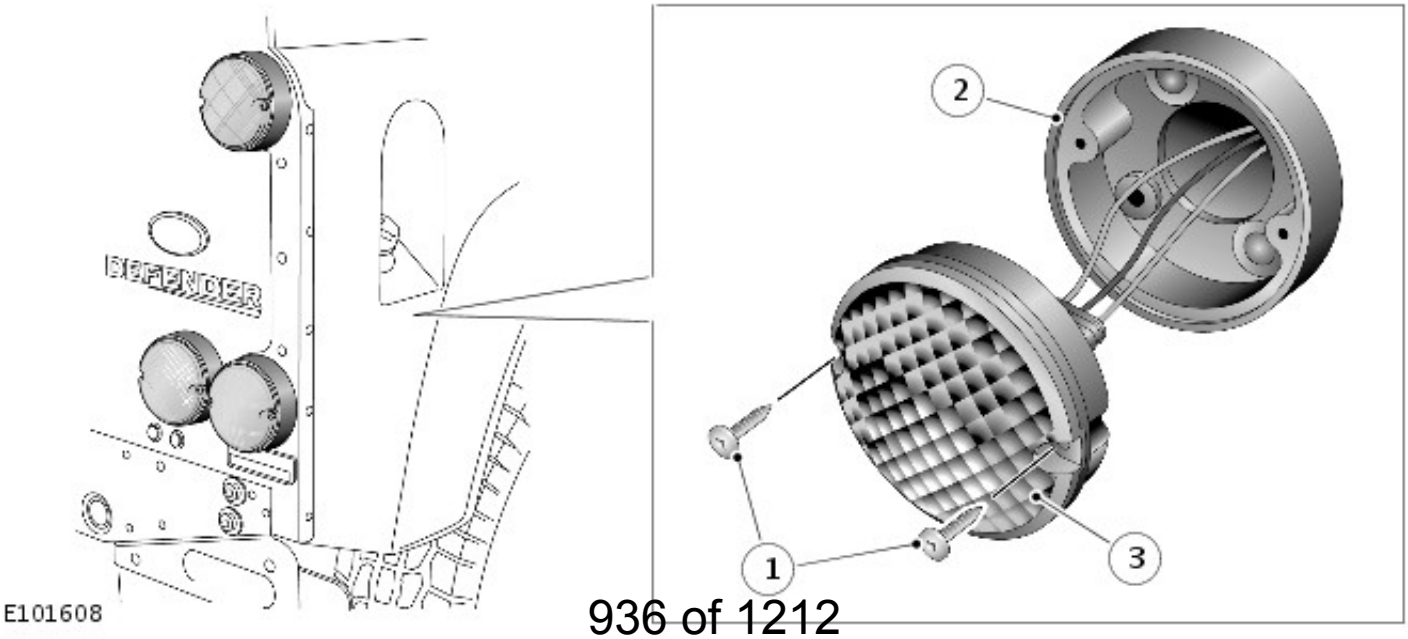


Item	Part Number	Description
1	-	Turn signal indicator lamp attachment hole (2 off)
2	-	Turn signal indicator lamp assembly
3	-	Turn signal indicator bulb
4	-	Bulb holder
5	-	Electrical connector

The front turn signal indicator lamp is unique to the SVX model. The lamp is located within the headlamp surround and is positioned on 2 lugs integral with the surround and secured with 2 self-tapping screws.

The lamp uses a PY21W Diadem bulb which is located in a holder in the rear of the lamp assembly. The holder has an integral connector which allows for connection to the main wiring harness via a short link harness which converts the main harness connector to the connector on the holder. The holder is rotated to lock or remove in the rear of the lamp unit. Access to the bulb requires removal of the headlamp surround.

LED Rear Lamps



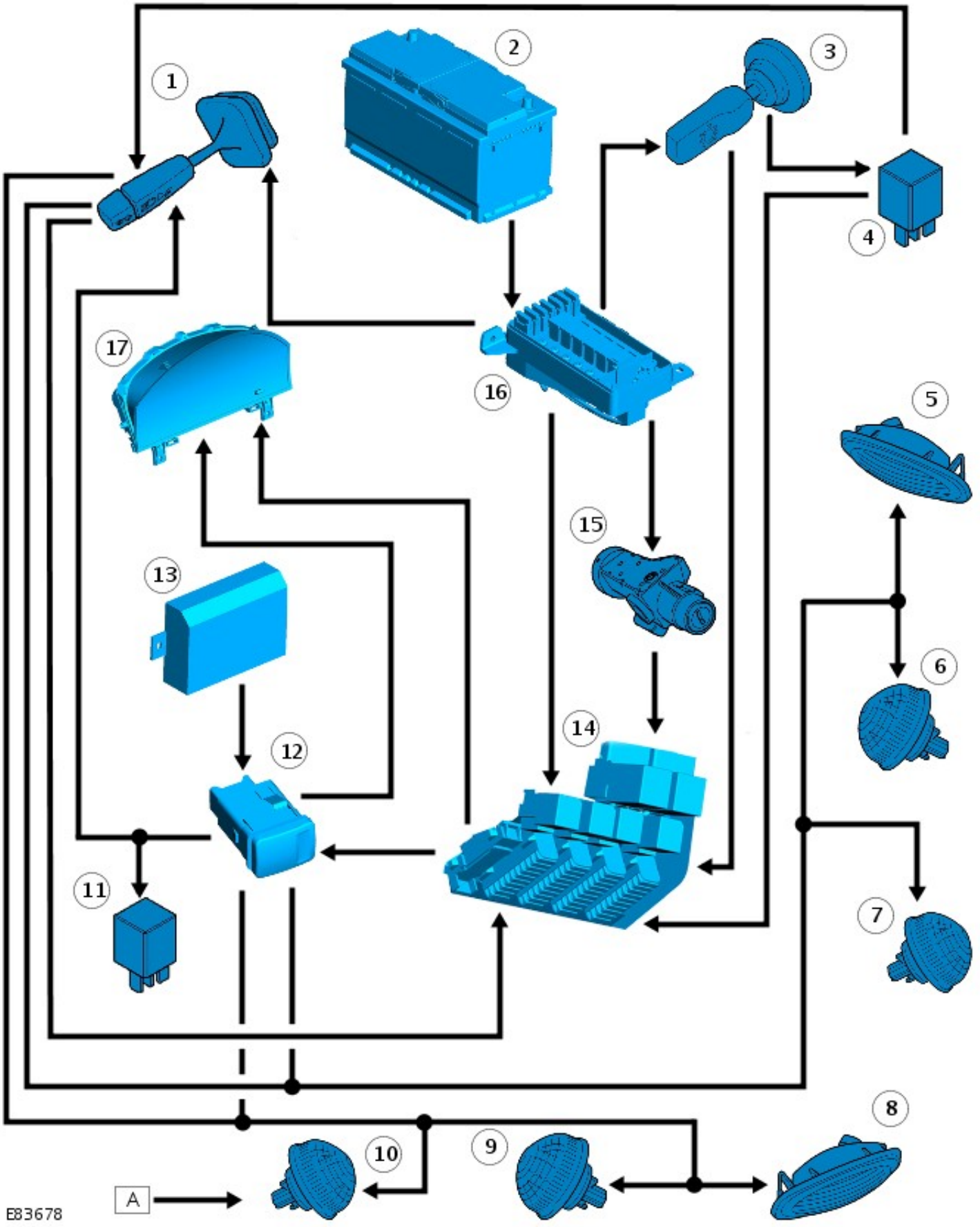
Item	Part Number	Description
1	-	Screw (2 off)
2	-	Housing
3	-	LED lamp assembly

The LED rear lamps are unique to the SVX model. The lamps all look similar when not illuminated with a white opaque lens. Once activated, the LED's illuminate in the applicable color for the lamp function.

The 2 upper rear lamps provide for the tail lamps and brake lamps. The inner of the lower lamps operate with the turn signal indicators. On left-hand drive (LHD) vehicles, the LH outer rear lamp is the rear fog lamp and the RH outer rear lamp is the reverse lamp. These 2 lamps alternate positions on a right-hand drive (RHD) vehicle.

CONTROL DIAGRAM - SHEET 1 OF 2 - MODELS FROM 2007MY (NOT SVX (60TH ANNIVERSARY) MODEL)

- NOTE: **A** = Hardwired

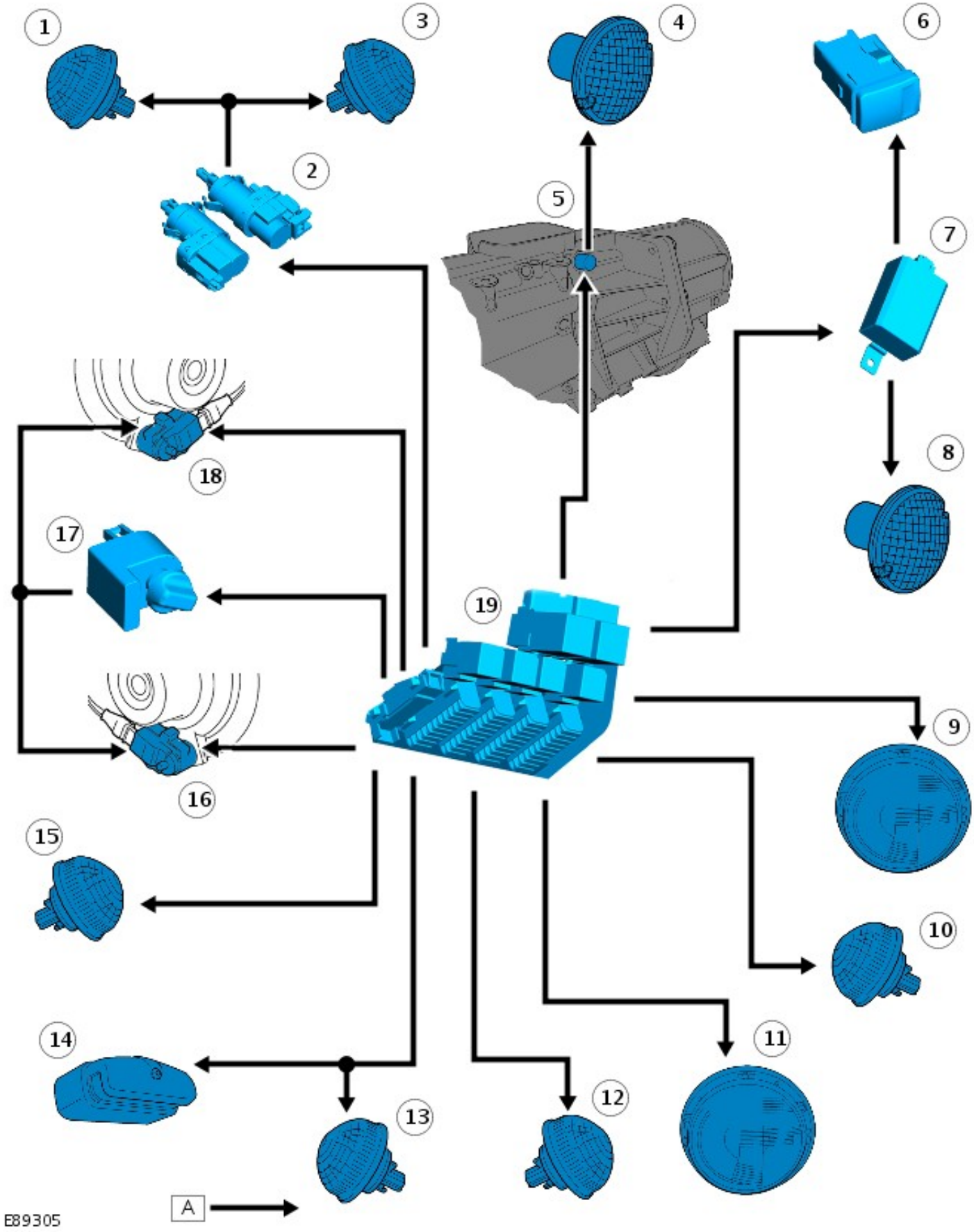


Item	Part Number	Description
1	-	Column switch
2	-	Battery
3	-	Lighting switch
4	-	Headlamp relay
5	-	RH side turn signal indicator lamp
6	-	RH front turn signal indicator lamp

7	-	RH rear turn signal indicator lamp
8	-	LH side turn signal indicator lamp
9	-	LH front turn signal indicator lamp
10	-	LH rear turn signal indicator lamp
11	-	Hazard flasher relay
12	-	Hazard flasher switch
13	-	Anti-theft system module
14	-	CJB
15	-	Ignition switch
16	-	BJB
17	-	Instrument cluster

CONTROL DIAGRAM - SHEET 2 OF 2 - MODELS FROM 2007MY (NOT SVX (60TH ANNIVERSARY) MODEL)

- NOTE: **A** = Hardwired

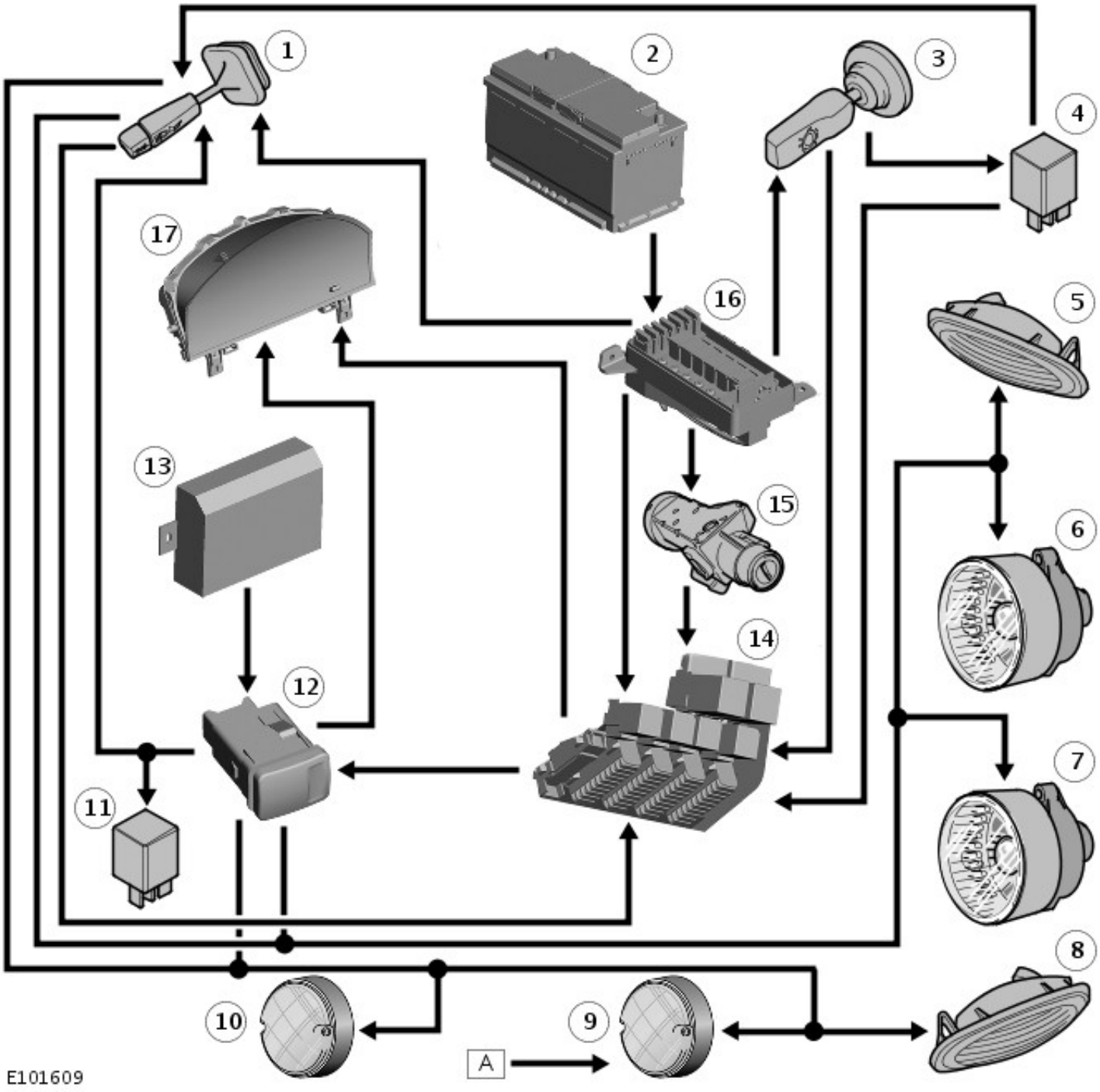


Item	Part Number	Description
1	-	LH stop lamp
2	-	Brake pedal switch
3	-	RH stop lamp
4	-	Reverse lamp
5	-	Reverse gear indicator switch
6	-	Fog lamp switch

7	-	Fog lamp control module
8	-	Fog lamp
9	-	LH headlamp
10	-	LH side lamp
11	-	RH headlamp
12	-	RH side lamp
13	-	LH tail lamp
14	-	License plate lamp
15	-	RH tail lamp
16	-	RH headlamp levelling motor (if fitted)
17	-	Headlamp levelling switch (if fitted)
18	-	LH headlamp levelling motor (if fitted)
19	-	CJB

CONTROL DIAGRAM - SHEET 1 OF 2 - (SVX (60TH ANNIVERSARY) MODEL)

• NOTE: **A** = Hardwired

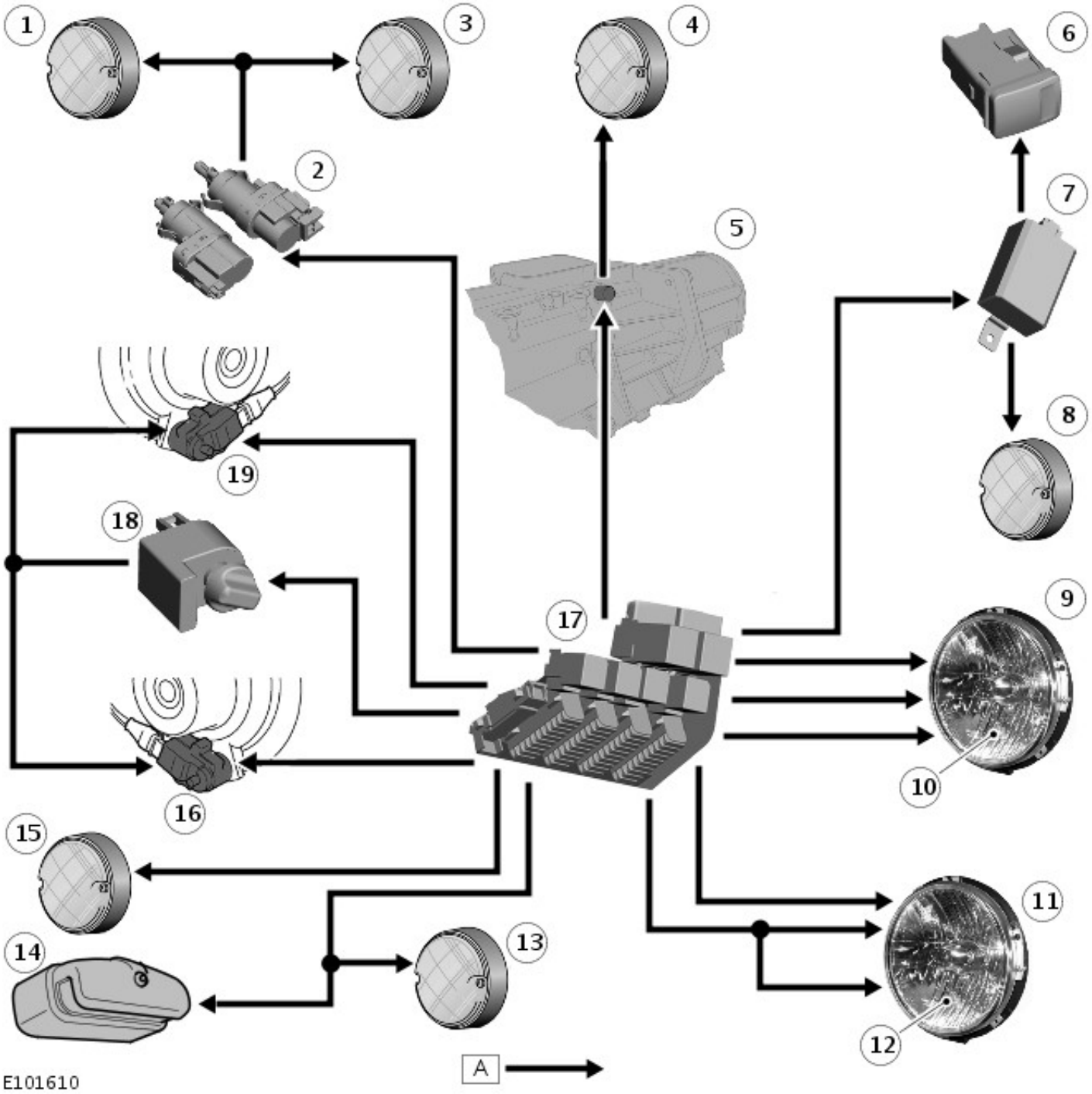


Item	Part Number	Description
1	-	Steering column multifunction switch

2	-	Battery
3	-	Lighting control switch
4	-	Headlamp relay
5	-	RH side turn signal lamp
6	-	RH front turn signal lamp
7	-	LH front turn signal lamp
8	-	LH side turn signal lamp
9	-	RH rear turn signal lamp
10	-	LH rear turn signal lamp
11	-	Hazard flasher relay
12	-	Hazard flasher switch
13	-	Anti-theft system module
14	-	CJB
15	-	Ignition switch
16	-	BJB
17	-	Instrument cluster

CONTROL DIAGRAM - SHEET 2 OF 2 (SVX (60TH ANNIVERSARY) MODEL)

- NOTE: **A** = Hardwired



Item	Part Number	Description
1	-	LH stop lamp
2	-	Brake pedal switch
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5	-	Reverse gear indicator switch
6	-	Fog lamp switch
7	-	Fog lamp control module
8	-	Fog lamp

9	-	LH headlamp
10	-	LH side lamp
11	-	RH headlamp
12	-	RH side lamp
13	-	LH tail lamp
14	-	License plate lamp
15	-	RH tail lamp
16	-	RH headlamp levelling motor (if fitted)
17	-	CJB
18	-	Headlamp levelling switch (if fitted)
19	-	LH headlamp levelling motor (if fitted)

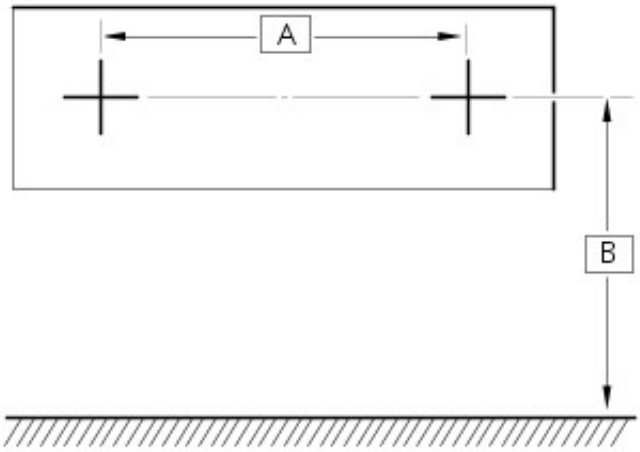
Exterior Lighting - Headlamp Adjustment

General Procedures

1. NOTE: Check main beam alignment using beam setting equipment. Should this not be available the beam can be temporarily checked and adjusted as follows.

Position vehicle, unladen, on level ground with tyres correctly inflated, approximately 4 metres from a wall or screen, marked as illustrated below.

2. The beam centres 'A' are measured horizontally on the vehicle and dimension 'B' vertically from the ground.



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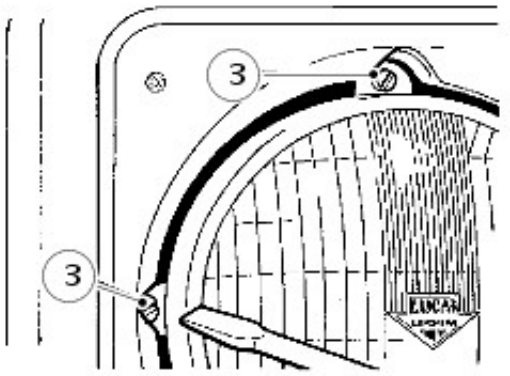
3. Switch on main beam and adjust setting, as necessary, with trimmer screws.



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Exterior Lighting - Headlamp Assembly

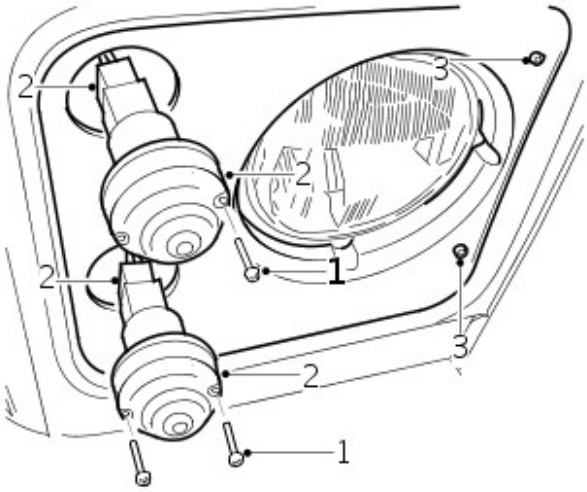
Removal and Installation

Removal

1. Remove 4 screws and release side and turn signal lamps from fender.

2. Disconnect multiplugs and remove side and turn signal lamps.

3. Remove 2 screws and remove headlamp finisher.



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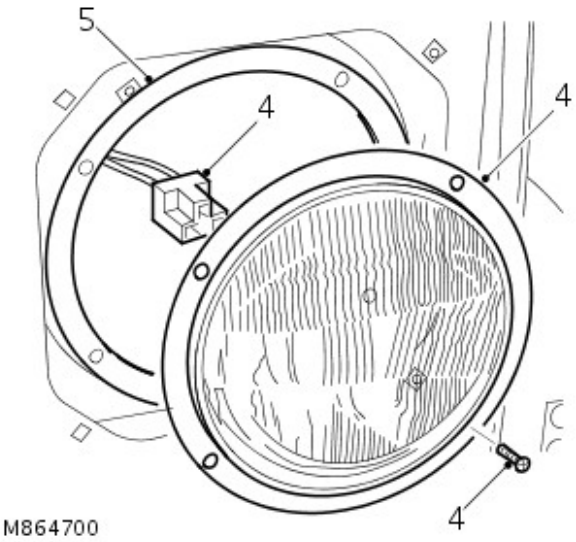
4. Remove 4 screws securing headlamp to fender, disconnect multiplugs and remove headlamp.

5. Remove headlamp seal.



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Installation

1. Fit headlamp seal.

2. Position headlamp, connect multiplugs, fit and tighten headlamp screws.

3. Fit headlamp finisher and secure with screws.

4. Position side and turn signal lamps, connect multiplugs and secure with screws.

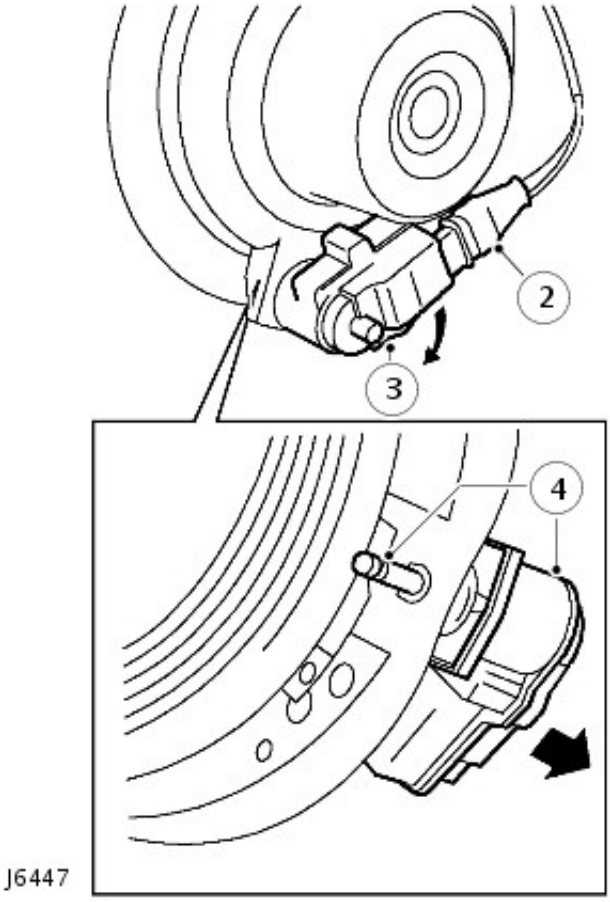
5. Reset headlamp alignment.
For additional information, refer to: Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).

Exterior Lighting - Headlamp Leveling Motor

Removal and Installation

Removal

1. Remove headlamp assembly.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
2. Disconnect headlamp leveling motor harness plug.
3. Rotate headlamp leveling motor anti-clockwise to release retaining lugs from mounting bracket on headlamp body.
4. Release headlamp leveling motor spindle from retaining slot on headlamp bezel and withdraw headlamp leveling motor from mounting bracket.



Installation

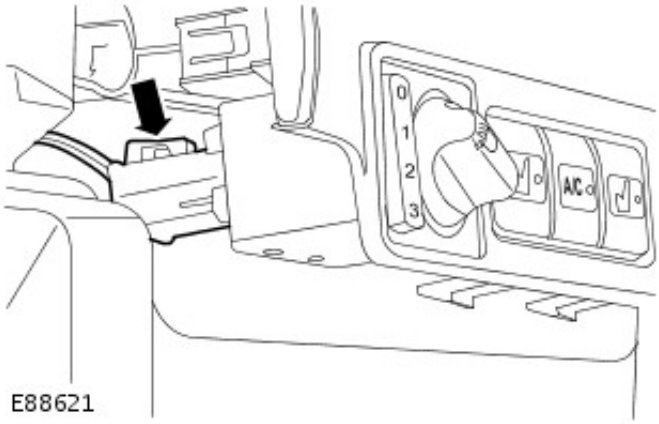
1. Instal headlamp leveling motor into mounting bracket and locate motor spindle into slot in headlamp bezel.
2. Press in headlamp leveling motor and rotate clockwise to engage retaining lugs behind mounting bracket.
3. Connect headlamp leveling motor harness plug.
4. Fit headlamp assembly.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).

Exterior Lighting - Headlamp Leveling Switch
Removal and Installation

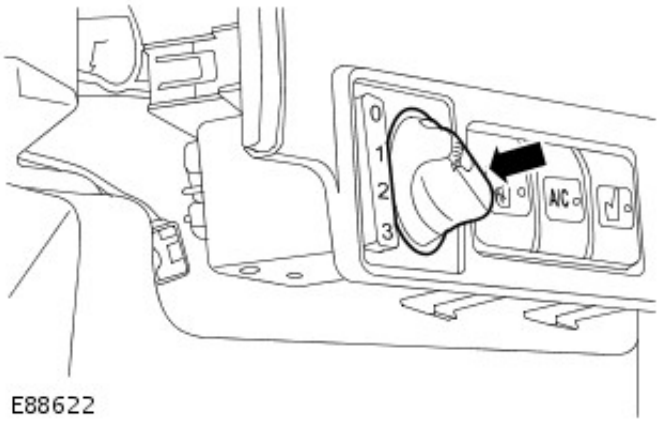
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. Release the instrument panel console.

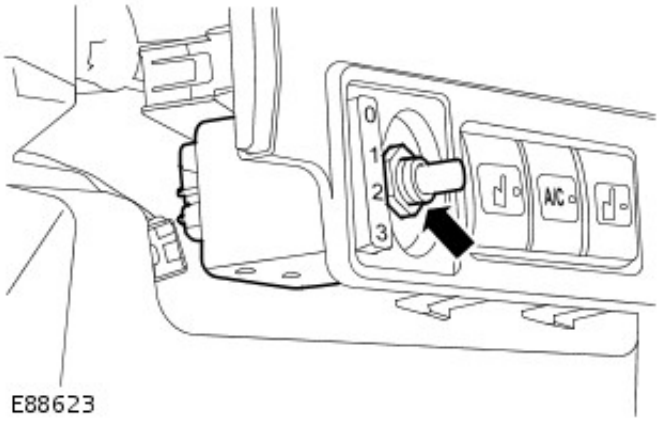
4. Disconnect the electrical connector.



5. Remove the headlamp leveling selector knob.



6. Remove the headlamp leveling switch.



- Remove the nut.

Installation

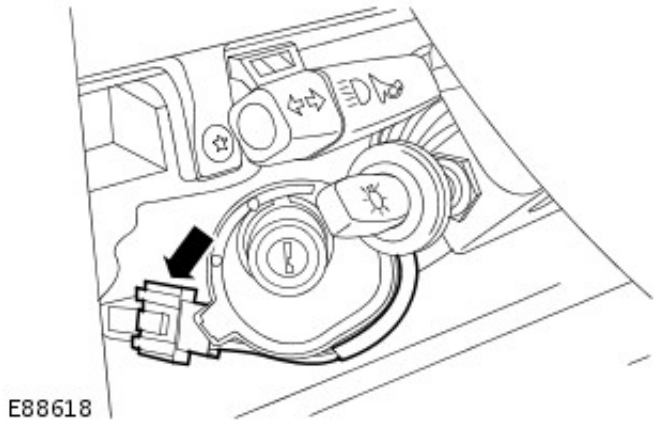
1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Exterior Lighting - Headlamp Switch

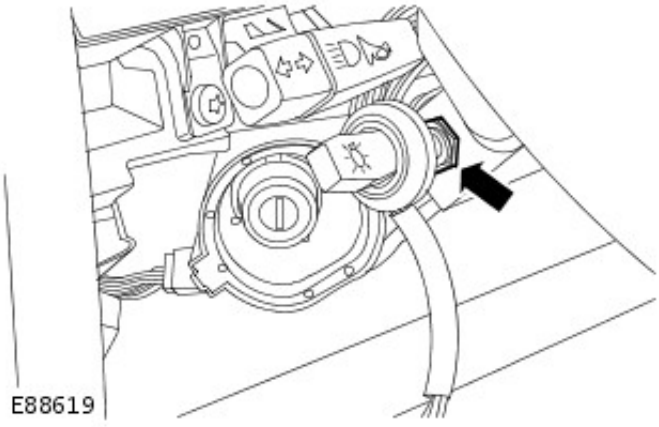
Removal and Installation

Removal

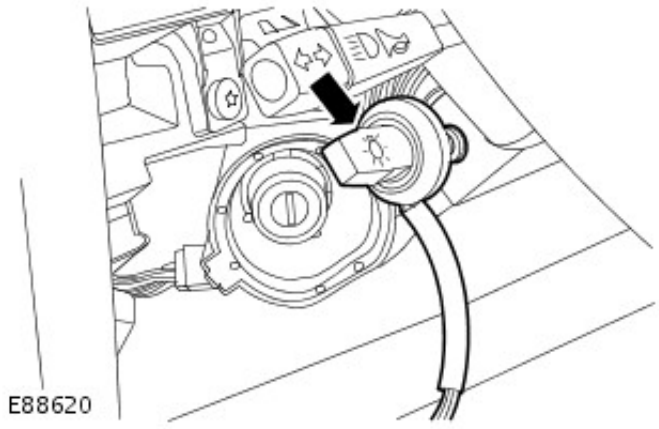
1. Remove the steering column shrouds.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect the electrical connector.



3. Release the nut.



4. Remove the headlamp switch.



Installation

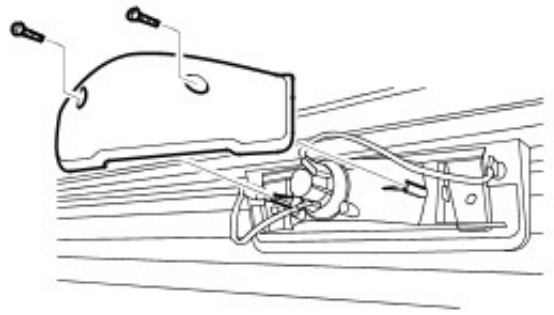
1. To install, reverse the removal procedure.

Exterior Lighting - High Mounted Stoplamp

Removal and Installation

Removal

1. Open rear door.
2. Remove 2 screws and cover from the high mounted stoplamp.



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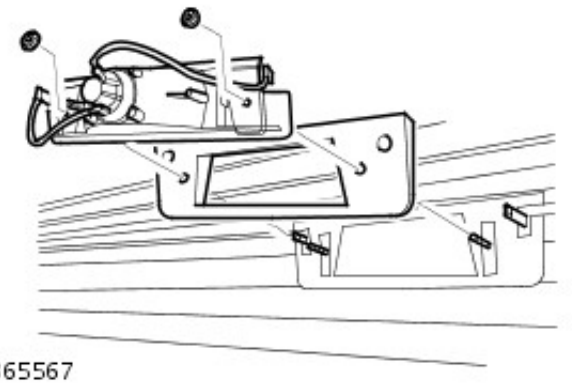
3. Remove insulated cover from connector, release catches and disconnect connectors taking care not to damage screen element.
4. Remove nuts securing lamp to rear screen, withdraw high mounted stoplamp, collect seals and washers.



M865567

5. Remove rubber backing pad, taking care not to damage screen obscuration band.

Installation

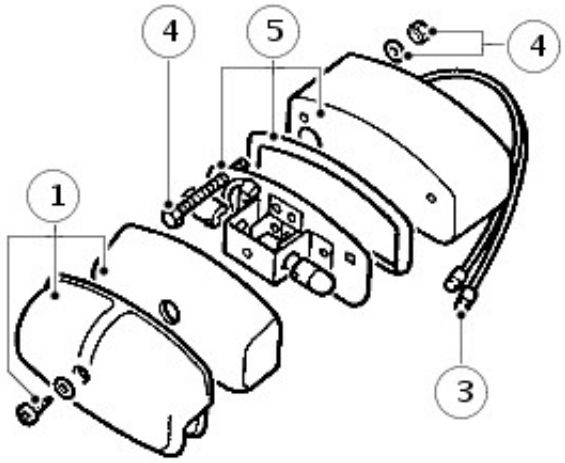
1. Clean obscuration band and fit new backing pad.
2. Fit high mounted stoplamp, seals and washers. Fit nuts and tighten to 3 Nm (2.2 lbf.ft).
3. Insulate connectors, and connect to rear screen.
4. Fit cover to high mounted stoplamp and secure with screws.

Exterior Lighting - License Plate Lamp

Removal and Installation

Removal

1. Remove single screw and remove lamp cover and lens.
2. Unscrew 2 fixings and remove metal cover to gain access to lamp fixings and harness leads inside vehicle.
3. Disconnect lamp leads from harness.
4. Remove 2 bolts, nuts and washers securing lamp to vehicle body.
5. Remove bulb holder, complete with rubber seal and mounting plinth.



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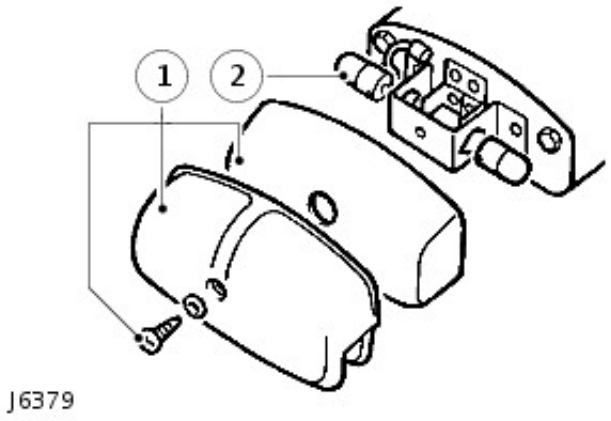
Installation

1. Feed lamp unit leads through vehicle body and secure bulb holder, seal and plinth.
2. Instal lamp leads to harness connectors.
3. Instal cover to conceal lamp fixings.
4. Instal lens and lamp cover.

Exterior Lighting - License Plate Lamp Bulb

Removal and Installation



Removal

1. Remove single screw securing lamp cover and lens to bulb holder.
2. Remove bulb/s from holder.

Installation

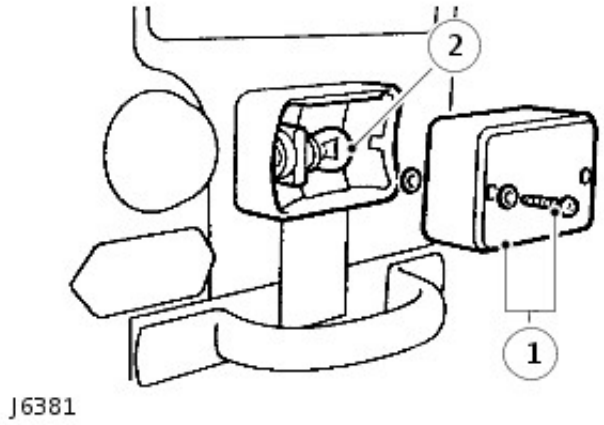
1. Install new bulb/s.
2. Install lamp lens and cover.

Exterior Lighting - Rear Fog Lamp Bulb

Removal and Installation

Removal

- NOTE: THis procedure covers removal and installation of reversing lamp bulb and rear fog lamp bulb.



1. Remove two screws with sealing washers and remove lens from lamp body.

2. Push and twist bulb to release from holder.

3. Clean interior of lamp and lens.

Installation

1. Fit new bulb.

2. Fit lens to lamp body.

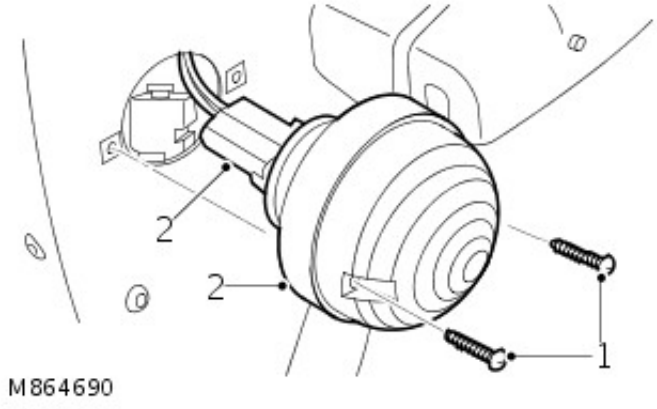
Exterior Lighting - Rear Lamp Assembly

Removal and Installation

Removal

1. Remove 2 screws securing rear lamp to body.

2. Disconnect multiplug and remove lamp.



Installation

1. Position rear lamp and connect multiplug.

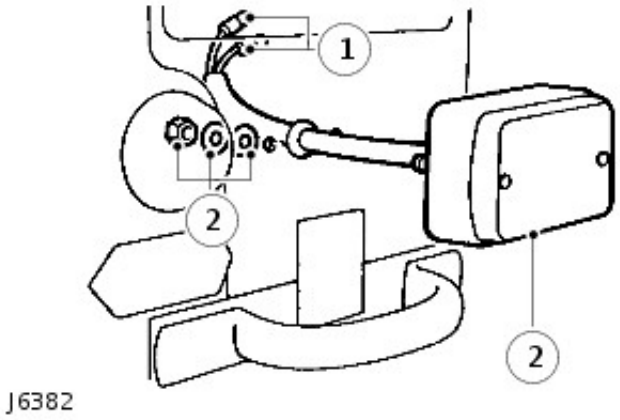
2. Fit and tighten lamp securing screws.

Exterior Lighting - Reversing Lamp

Removal and Installation

Removal

- NOTE: This procedure covers removal and installation of the reversing lamp and the rear fog lamp.



1. From underneath the vehicle, lift protective flap and disconnect lamp leads at harness connectors.
2. Unscrew 2 nuts and washers and withdraw lamp unit from vehicle.

Installation

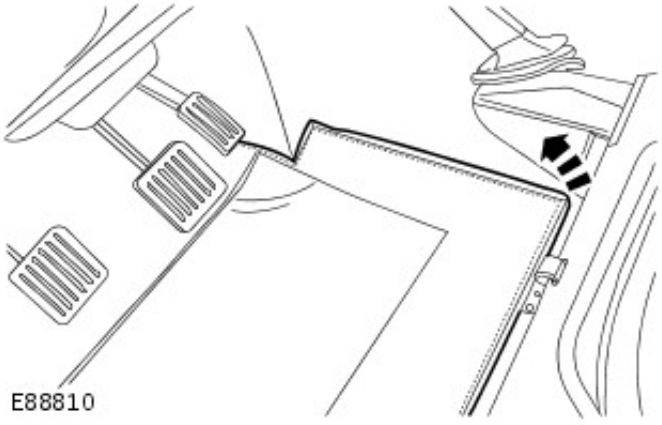
1. Feed lamp leads through grommet and locate lamp studs in vehicle body.
2. Fit retaining nuts and reconnect lamp leads to vehicle harness.

Exterior Lighting - Reversing Lamp Switch
Removal and Installation

Removal

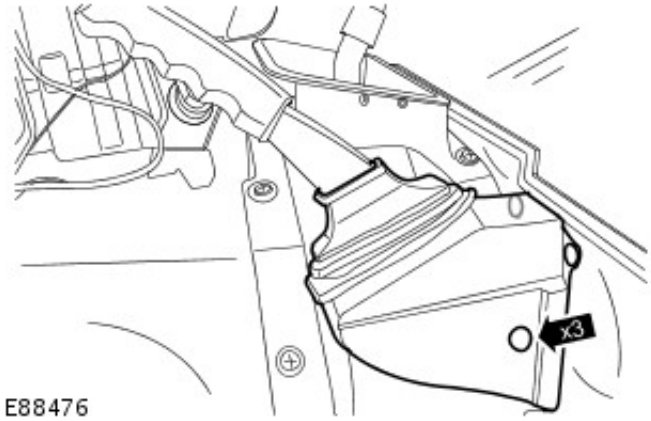
1. Remove the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

2. Reposition the LH carpet.



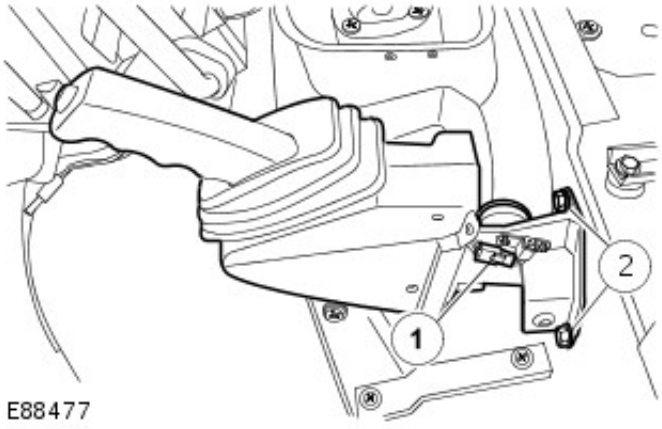
3. Release the parking brake lever gaiter.

- Remove the 3 clips.

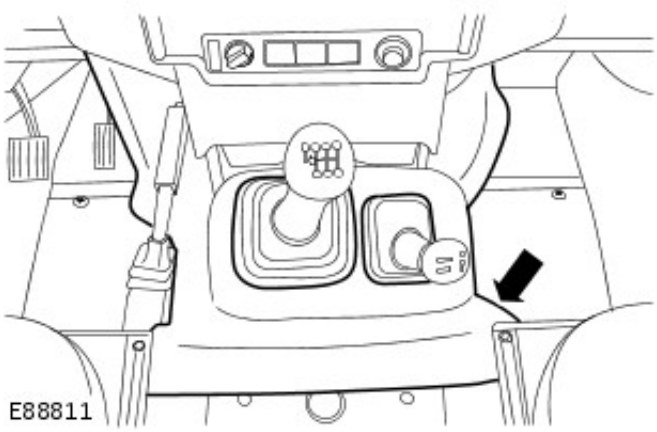


4. Release the parking brake lever.

1. Disconnect the electrical connector.
2. Remove the 2 bolts.

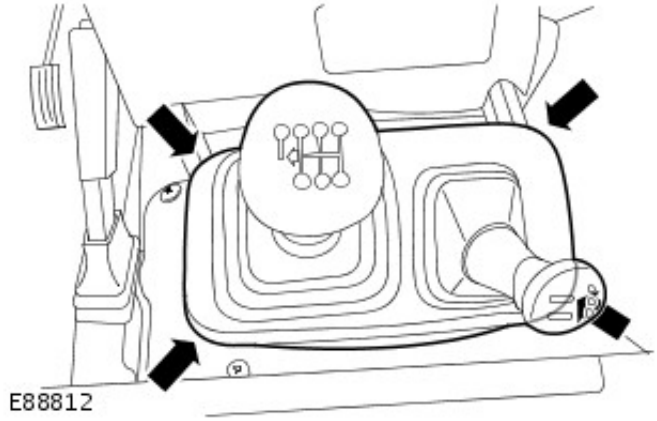


5. Remove the transmission cover panel floor covering.



6. NOTE: Do not detach the gaiter from the selector knobs.

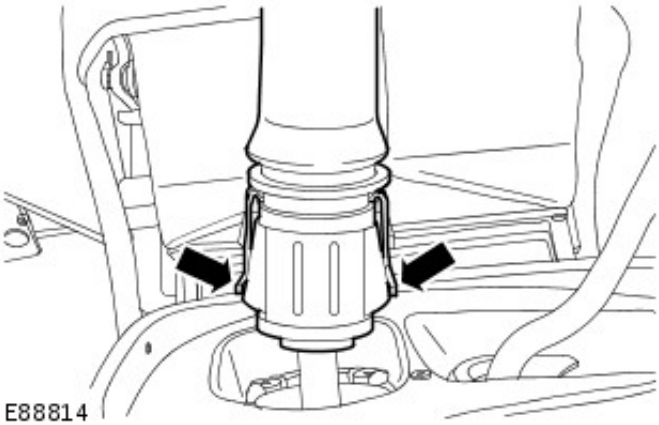
Detach the gaiter from the transmission cover panel.



7. WARNING: The gearshift lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Release the gearshift lever knob.

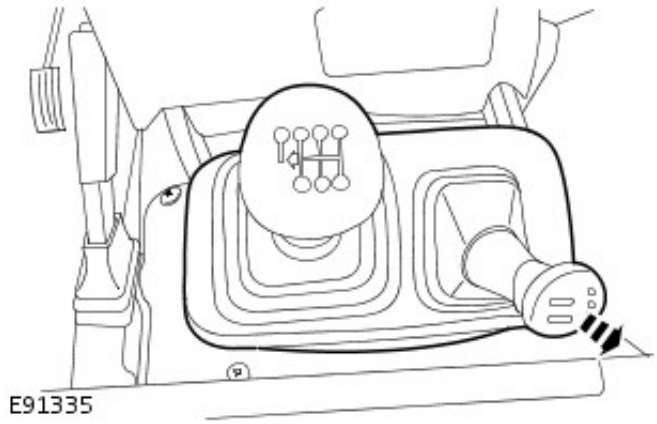
- Release the 2 clips.



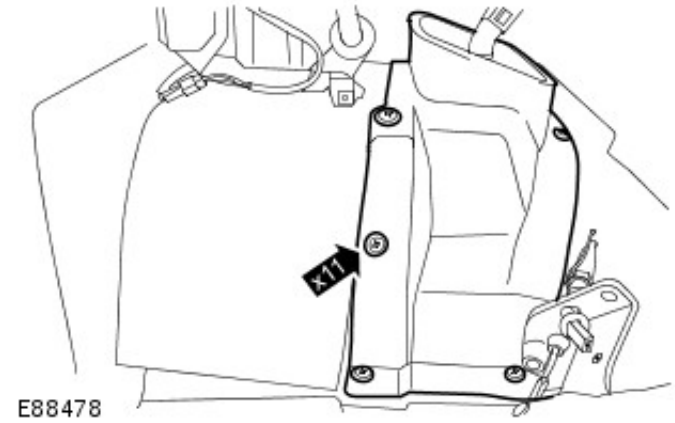
8. WARNING: The high/low range lever knob will be released suddenly, keep face clear during removal. Failure to follow this instruction may result in personal injury.

Remove the gaiter and selector levers.

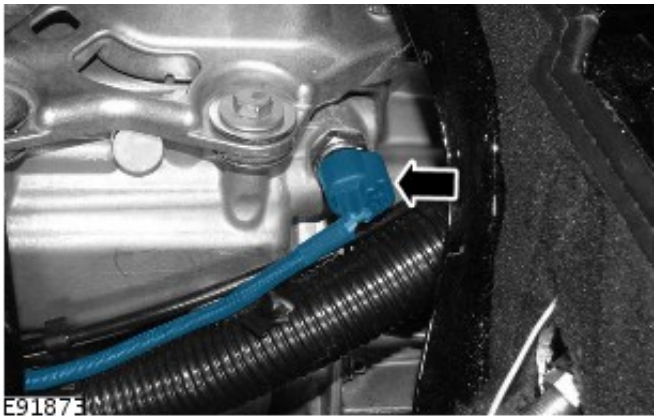
- Detach the high/low range selector lever.



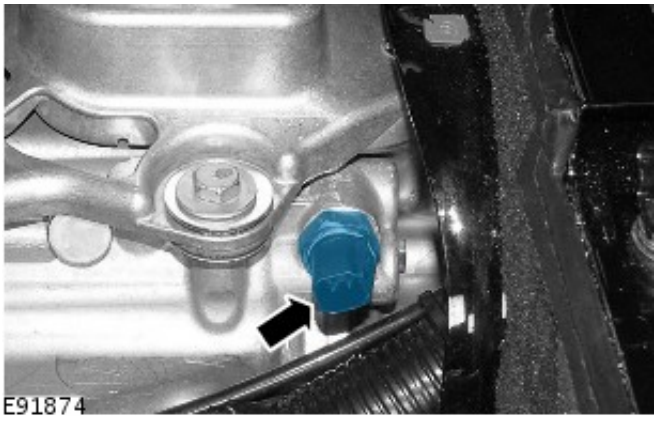
9. Remove the transmission cover panel.



- Remove the 11 screws.



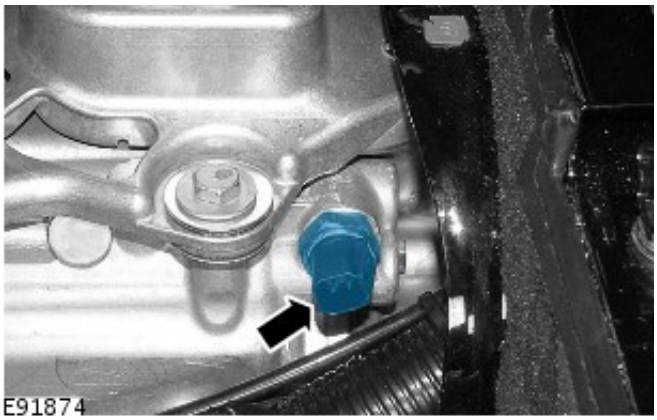
10. Disconnect reversing lamp switch connector.



11. Remove the reversing lamp switch.

- Remove and discard the O-ring seal.

Installation



1. Install the reversing lamp switch.

- Install a new O-ring seal.
- Tighten to 20 Nm (15 lb/ft).

2. Connect the reversing lamp switch electrical connector.

3. Install the transmission cover panel.

- Install the screws.

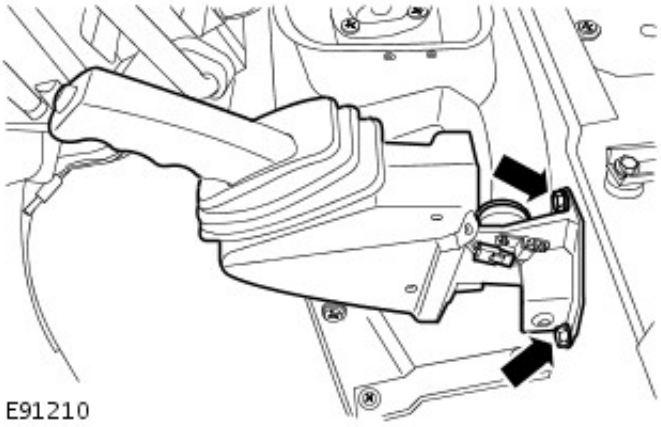
4. Install the gaiter with the selector levers attached.

- Install the selector levers.
- Fully seat the gaiter.

5. Install the transmission cover panel floor covering.

6. Install the parking brake lever.

- Tighten to 25 Nm (18 lb.ft)



7. Install the parking brake lever gaiter.

- Install the clips.

8. Reposition the LH carpet.

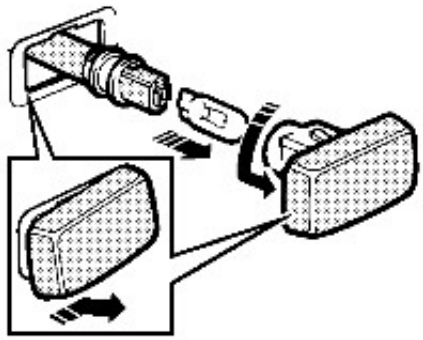
9. Install the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

Exterior Lighting - Side Marker Lamp

Removal and Installation

Removal

- NOTE: This procedure covers removal and installation of the side repeater lamp.



J6378

1. Push lens firmly to the right.
2. Lift left edge and withdraw lamp unit from wing.
3. Twist bulb holder and release from lens.
4. Pull bulb from holder.

Installation

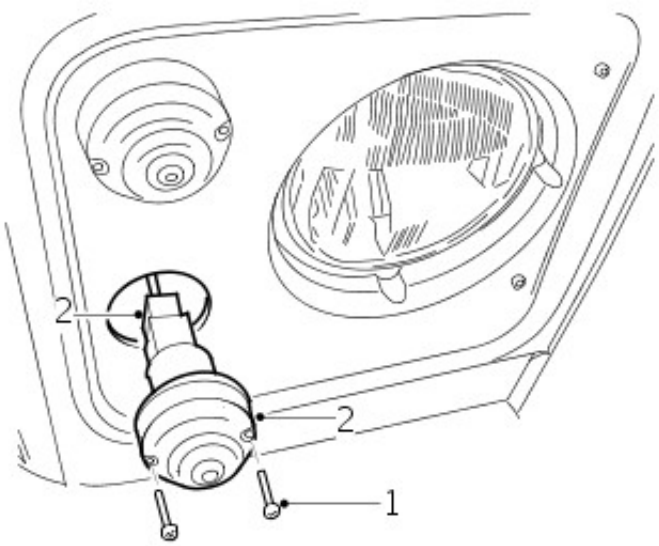
1. Fit new bulb, if necessary.
2. Fit bulb holder to lens.
3. Locate lamp unit in wing and push firmly to the left to secure.

Exterior Lighting - Side Turn Signal Lamp

Removal and Installation

Removal

1. Remove 2 screws securing side turn signal lamp to front fender.
2. Disconnect multiplug and remove lamp.



M864696

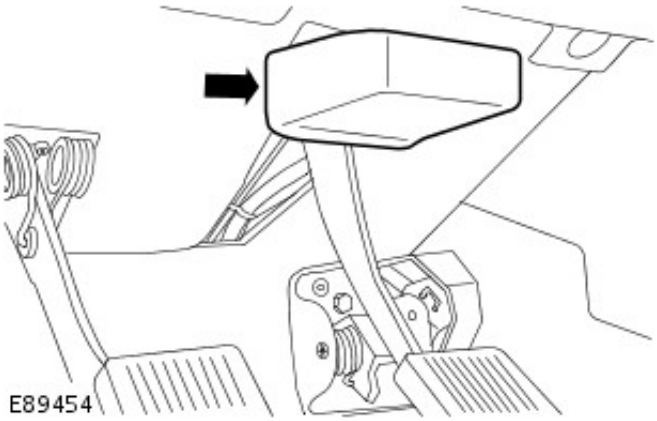
Installation

1. Position side turn signal lamp and connect multiplug.
2. Fit and tighten lamp securing screws.

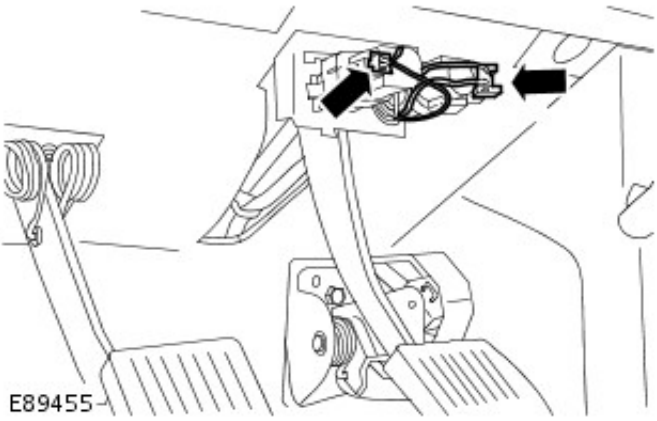
Exterior Lighting - Stoplamp Switch

Removal and Installation

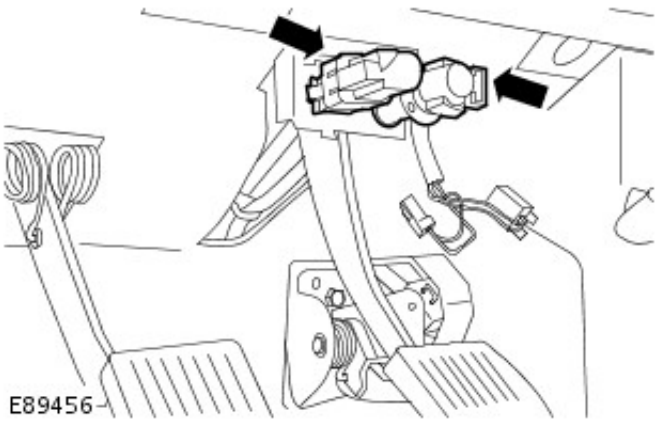
Removal



1. Remove the stoplamp switch cover.



2. Disconnect the electrical connectors.



3. Remove the stoplamp switches.

Installation

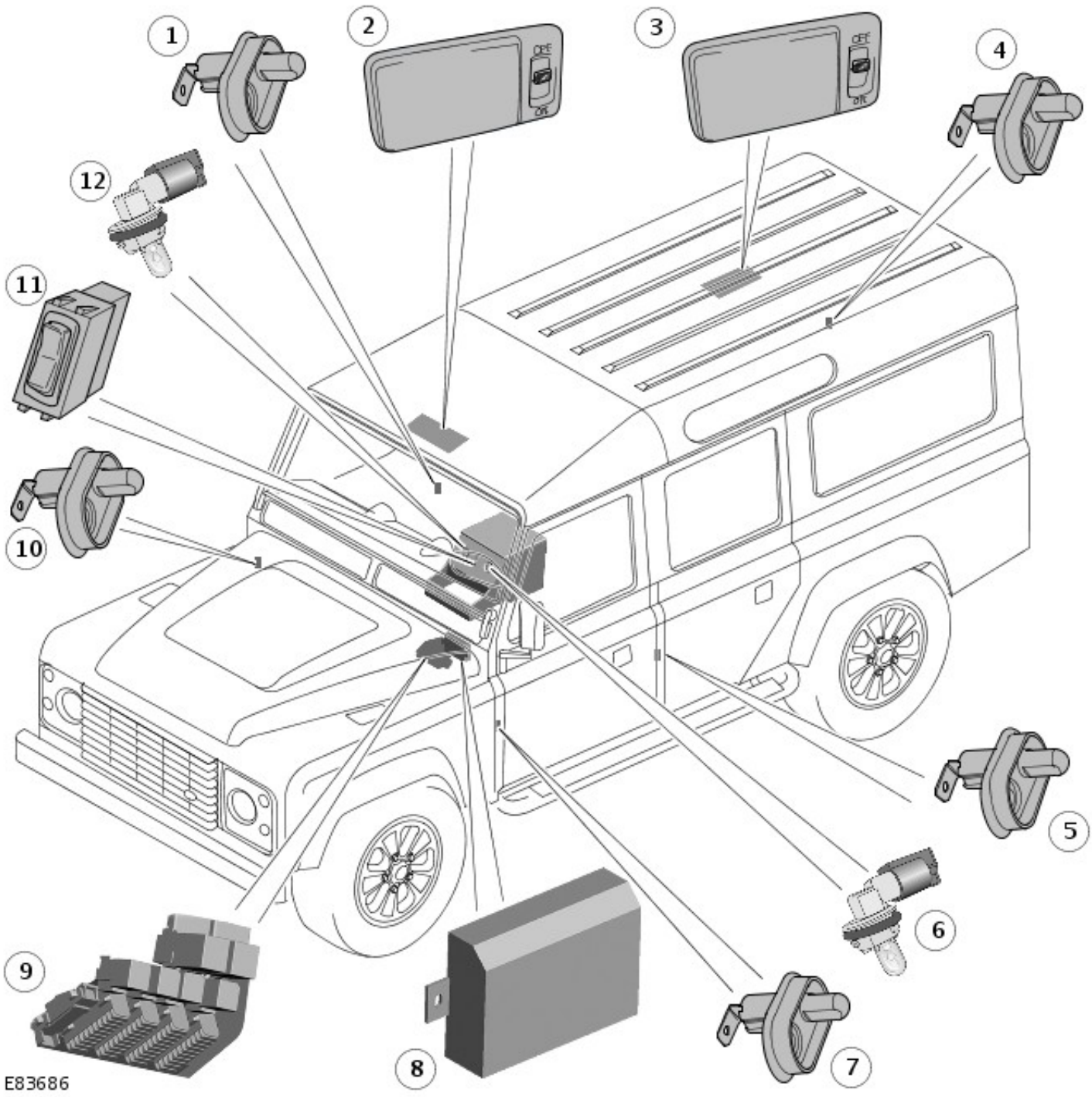
1. CAUTION: Make sure that the brake pedal is kept in the rest position and is not pressed or moved during the instillation of the stoplamp switch. Failure to follow this instruction may result in damage to the vehicle.

To install, reverse the removal procedure.

Interior Lighting - Interior Lighting
Description and Operation

COMPONENT LOCATION

• NOTE: left-hand drive (LHD) vehicle shown, right-hand drive (RHD) similar.



Item	Part Number	Description
1	-	right-hand (RH) rear door switch (if fitted)
2	-	Front interior lamp
3	-	Rear interior lamp (Not 90 model)
4	-	Tail door switch (Not 90 model)
5	-	left-hand (LH) rear door switch (if fitted)
6	-	Map reading lamp (SVX (60th anniversary) model only)
7	-	Drivers door switch
8	-	Anti-theft system module
9	-	central junction box (CJB)
10	-	Passenger door switch
11	-	Map reading lamps switch (SVX (60th anniversary) model only)

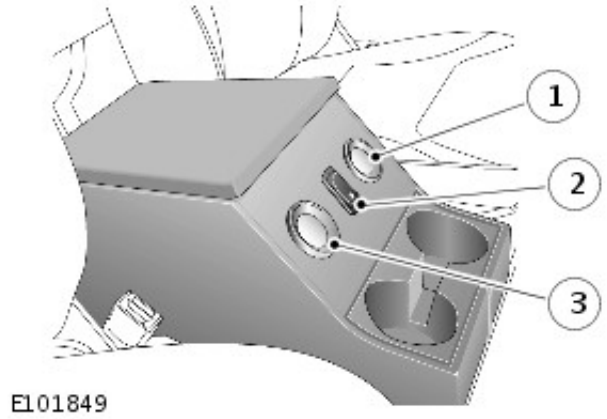
12	-	Map reading lamp (SVX (60th anniversary) model only)

OVERVIEW

Each interior lamp contains a 3 way switch, allowing always on, always off, or automatic operation. When in the always on position, the interior lamp is provided with a battery voltage feed from the CJB. When in the automatic position, operation of the interior lamps is controlled by the anti-theft system module. The anti-theft system module monitors the condition of the doors, including the tail door, through a series of switches. If any of the doors are opened a ground path is created through the relevant switch. When the anti-theft system module registers a ground path it illuminates the interior lamps. If the door(s) are subsequently closed, the anti-theft system module will extinguish the interior lamps after a period of 15 seconds.

The anti-theft system module will also illuminate the interior lamps if it receives a valid unlock signal from the remote radio frequency (RF) handset.
For additional information, refer to: Anti-Theft - Active (419-01A Anti-Theft - Active, Description and Operation).

SVX (60th Anniversary) Model



Item	Part Number	Description
1	-	LH map reading lamp
2	-	Map reading lamps control switch
3	-	RH map reading lamp

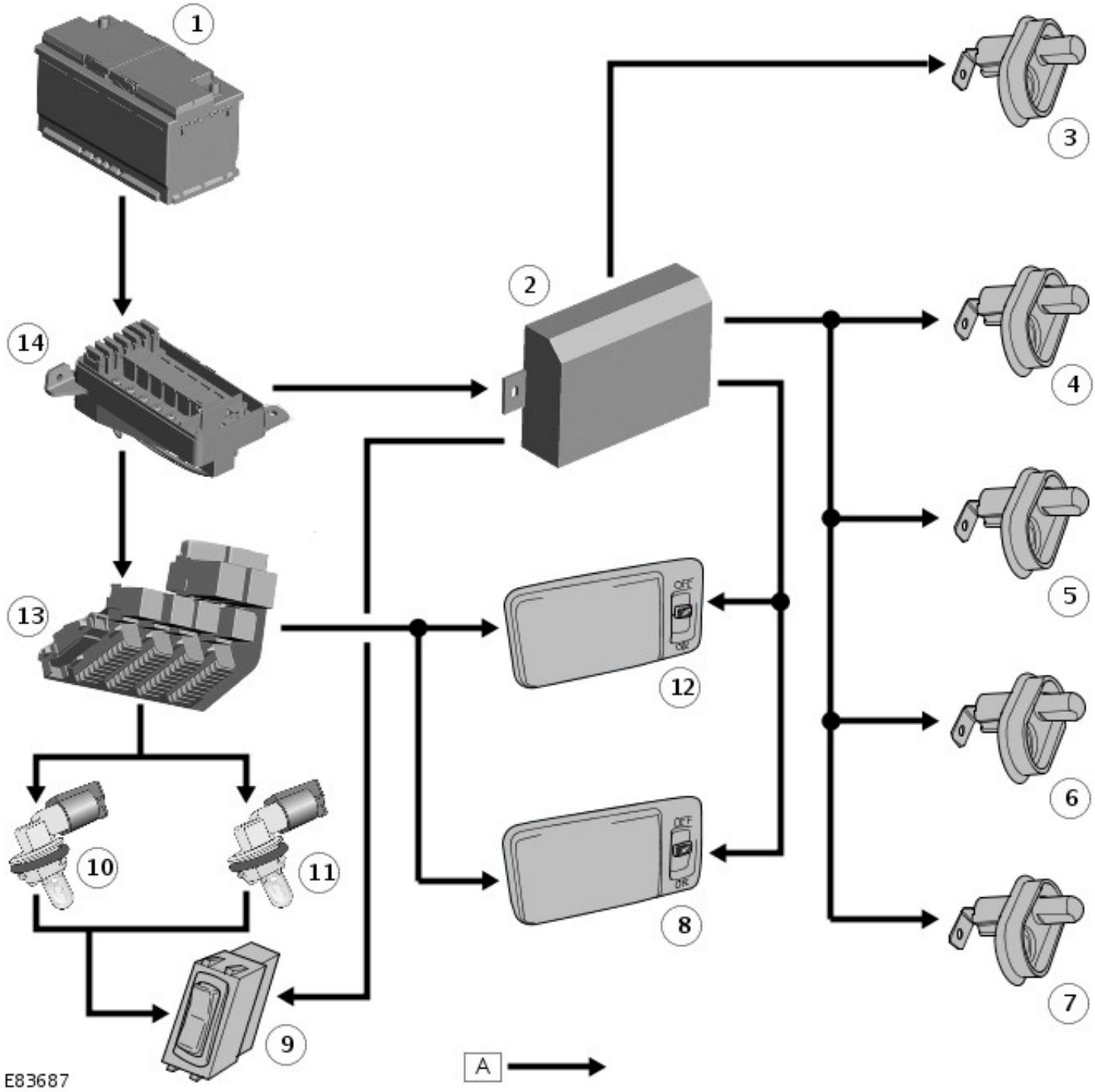
The SVX model has all the interior lighting features of the standard models but with the addition of 2 map reading lamps.

The map reading lamps are located on the forward face of the cubby box with a control switch positioned between them. The lamps use a W3W bulb. The bulb can be replaced by carefully levering the lamp from the cubby box using a suitable tool and removing the bulb holder from the rear of the lamp.

The map reading lamps are connected directly to the vehicle battery via fuses in the CJB and the battery junction box (BJB). Therefore the map reading lamps can be operated independent of the ignition switch position. Each lamp receives a battery voltage supply and the lamp illuminates when the switch is operated which completes a ground path.

CONTROL DIAGRAM

- NOTE: **A** = Hardwired



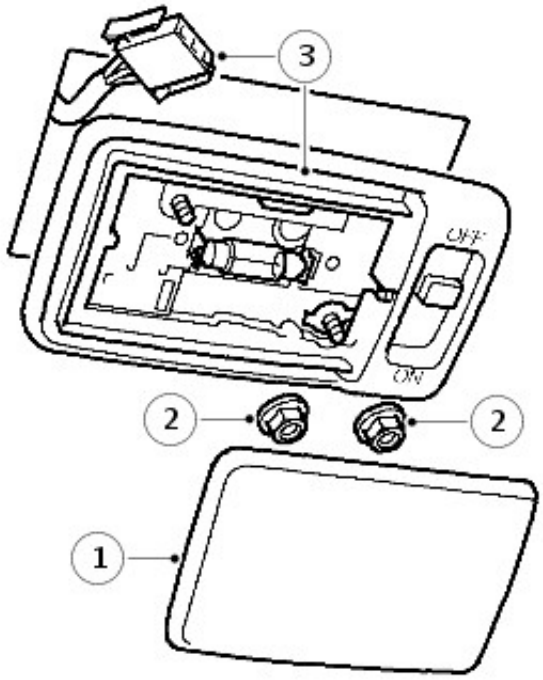
Item	Part Number	Description
1	-	Battery
2	-	Anti-theft system module
3	-	Drivers door switch
4	-	Passenger door switch
5	-	Tail door switch
6	-	LH rear door switch (if fitted)
7	-	RH rear door switch (if fitted)
8	-	Rear interior lamp
9	-	Map reading lamps switch (SVX (60th anniversary) model only)
10	-	LH map reading lamp (SVX (60th anniversary) model only)
11	-	RH map reading lamp (SVX (60th anniversary) model only)
12	-	Front interior lamp
13	-	CJB
14	-	BJB

Interior Lighting - Interior Lamp

Removal and Installation

Removal

1. Prise lens cover from lamp unit.
2. Remove 2 nuts securing lamp unit to headlining and roof mounting bracket.
3. Remove lamp unit from mounting bracket studs and disconnect harness plug.



J6063

4. Remove interior lamp.

Installation

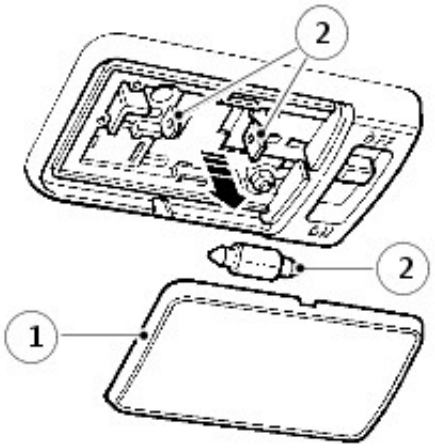
1. Reconnect harness plug and locate lamp unit on mounting bracket studs. Ensure lamp switch eyelet is correctly seated on lamp unit base.
2. Secure lamp unit to mounting bracket and fit lamp lens.

Interior Lighting - Interior Lamp Bulb

Removal and Installation

Removal

1. Prise lens from lamp unit.
2. Spread bulb holder contacts and release bulb.



J6383

Installation

1. Spread bulb holder contacts and fit new bulb.
2. Fit lamp lens.

Module Communications Network - Communications Network

Description and Operation

OVERVIEW

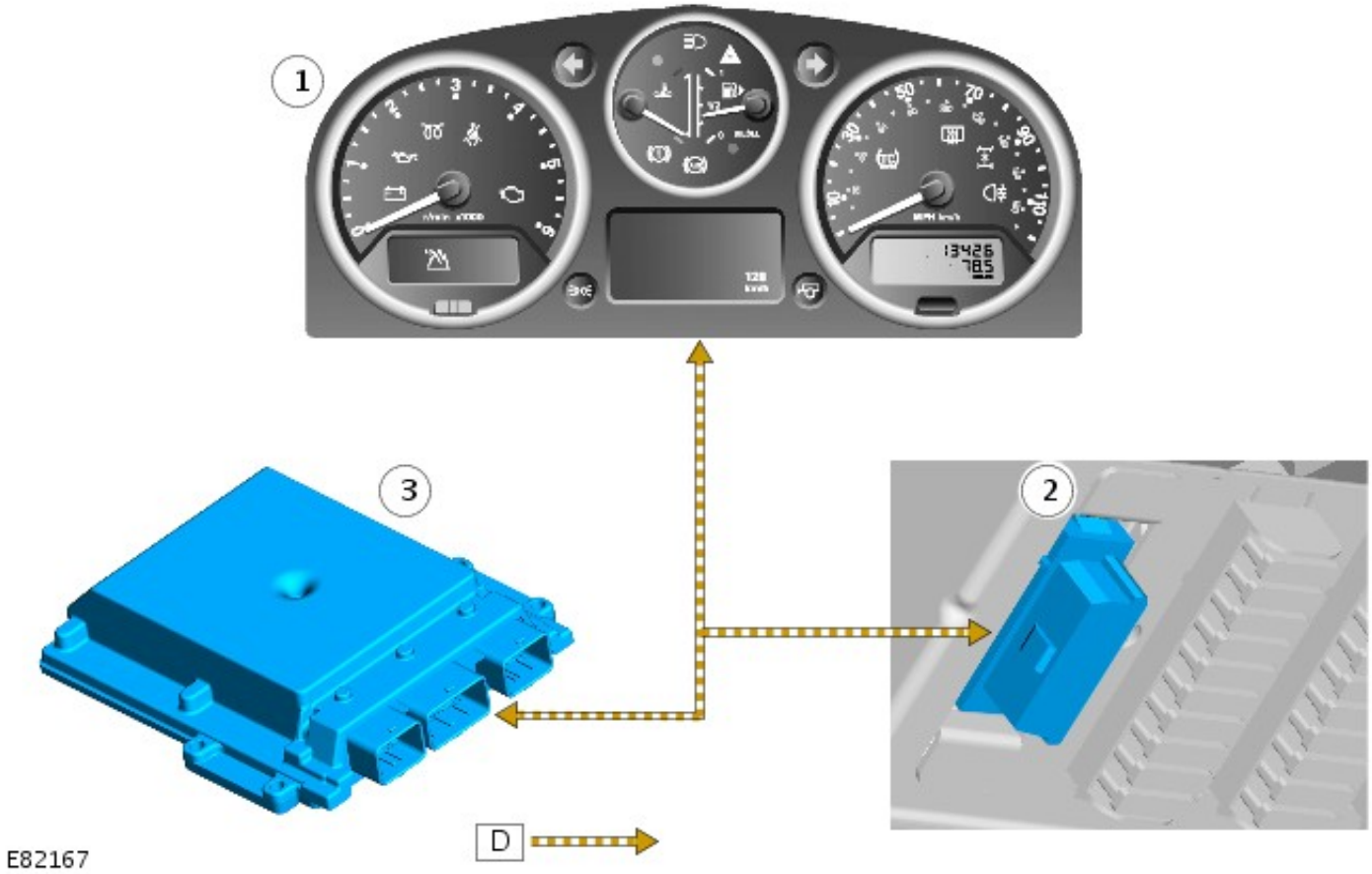
A high speed controller area network (CAN) bus is used to transfer data between the engine control module (ECM) and instrument cluster.

The diagnostic socket is also connected to the high speed CAN bus and allows the Land Rover approved diagnostic system to interrogate both the ECM and instrument cluster software.

The CAN bus is a high speed broadcast network where control modules automatically transmit information every few microseconds. Information is broadcast down a pair of twisted wires, known as 'CAN high' and 'CAN low'. Information is transmitted on the CAN bus as a voltage difference between the 2 wires.

CONTROL DIAGRAM

• NOTE: **D** = High speed CAN bus

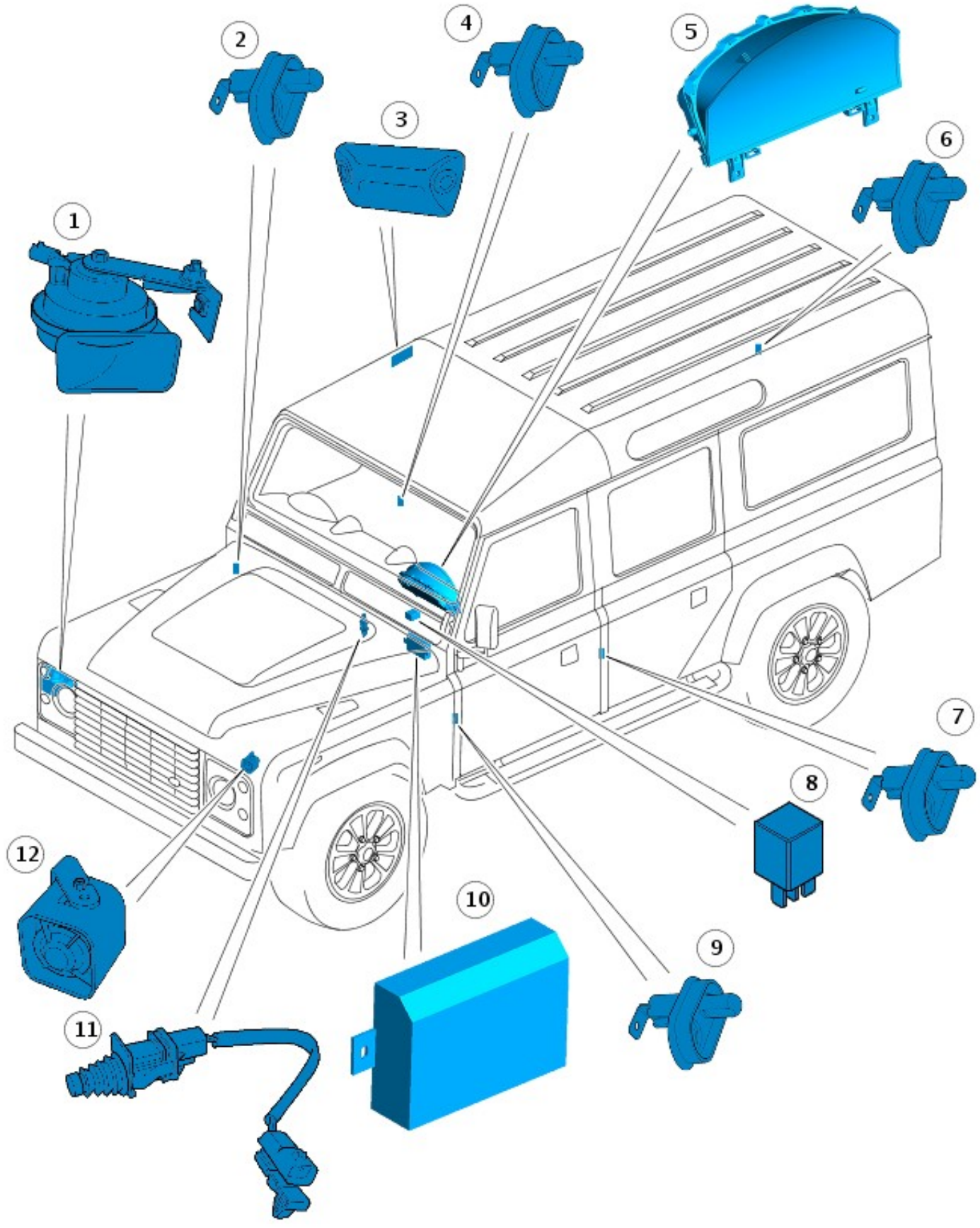


Item	Part Number	Description
1	-	Instrument cluster
2	-	Diagnostic socket
3	-	ECM

Anti-Theft - Active - Anti-Theft - Active

Description and Operation

COMPONENT LOCATION



Item	Part Number	Description
1	-	Anti-theft alarm horn (if fitted)

2	-	right-hand (RH) front door switch
3	-	Intrusion detection module (90/110 station wagon shown)
4	-	RH rear door switch (if fitted)
5	-	Instrument cluster
6	-	Tail door switch
7	-	left-hand (LH) rear door switch (if fitted)
8	-	Anti-theft alarm horn relay (if fitted)
9	-	LH front door switch
10	-	Anti-theft system module
11	-	Hood switch
12	-	Battery backed sounder (if fitted)

OVERVIEW

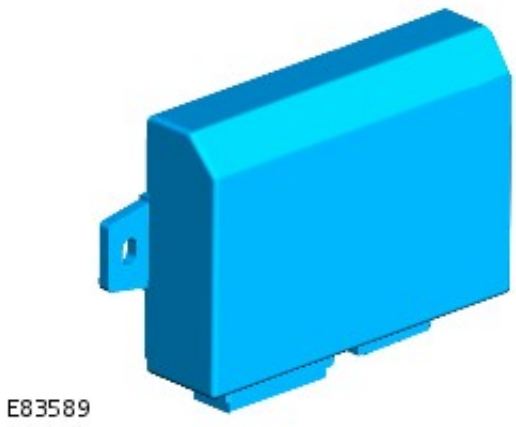
The 10AS anti-theft system monitors the hinged panels for unauthorized opening. The system also monitors intrusion within the cabin. Depending on market specification, the vehicle may be fitted with either a battery backed sounder or an anti-theft alarm horn.

The controlling software for the active anti-theft system is contained within the anti-theft system module. The anti-theft system module also controls;

- the passive anti-theft system (engine immobilization).
  For additional information, refer to: Anti-Theft - Passive (419-01B Anti-Theft - Passive, Description and Operation).
- the central locking system.
  For additional information, refer to: Handles, Locks, Latches and Entry Systems (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).
- interior lighting.
  For additional information, refer to: Interior Lighting (417-02 Interior Lighting, Description and Operation).
- the hazard flashers.
  For additional information, refer to: Exterior Lighting (417-01 Exterior Lighting, Description and Operation).

The active anti-theft system is armed by pressing the lock button on the remote handset or using the vehicle key in the drivers door lock. Using the remote handset will arm both the perimetric and volumetric anti-theft systems. Using the vehicle key will only arm the perimetric anti-theft system.

ANTI-THEFT SYSTEM MODULE



The anti-theft system module is located behind the instrument cluster and receives a permanent battery supply from the battery junction box (BJB). The control module incorporates a radio frequency (RF) receiver and antenna to receive signals transmitted from the remote handset.

Depending on market specification, the module will operate at one of two frequencies. This is identified by a label mounted on the module casing. The table below shows the frequencies available for each market.

Frequency	Markets
433 MHz	Europe, Gulf States, South Africa
315 MHz	North America, South East Asia, Japan, Australia

The anti-theft system module also incorporates an internal inertia switch. In the event of an impact of sufficient severity to trigger the inertia switch when the ignition switch is in position II, the anti-theft system module will unlock all doors and operate the hazard flashers. The anti-theft system module will remain in this mode of operation for 2 minutes. To de-activate the hazard flashers and restore the anti-theft system module to its normal mode of operation, the ignition switch should be turned to position 0 and back to position II after the 2 minute period has expired.

REMOTE HANDSET

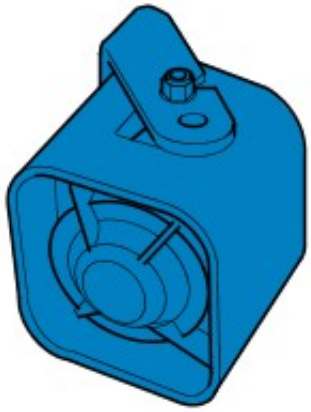
E83590

The remote handset is used to arm and disarm the anti-theft alarm system. The handset comprises a lock and unlock button. Internally, the handset contains a printed circuit board capable of transmitting RF signals, and a battery.

The remote handset RF code comprises 2 parts. The first part is a fixed code that is unique to the handset. The second part is a rolling code which changes in accordance with a pre-determined pattern. The code is received by the anti-theft system module, which is able to store information on up to 4 different handsets.

If the remote handset battery falls below a pre-determined level, the handset will transmit an additional RF signal code to the anti-theft system module. This signal is relayed to the instrument cluster indicator which emits 2 rapid flashes every 0.5 seconds to inform the driver that the remote handset battery needs replacing.

BATTERY BACKED SOUNDER



E83591

Depending on market specification, the vehicle may be fitted with a battery backed sounder. The battery backed sounder is located in the LH front fender, behind the headlamp. The battery backed sounder is tamper proof and as the name suggests contains its own power supply. This allows it to operate even if it is disconnected from the vehicle power supply. For added security all wires leading to and from the battery backed sounder are colored black.

If the battery backed sounder is disconnected without first being disarmed it will sound for 4 minutes 30 seconds, if not reset in the interim. The alarm cycle in this period will be made up of a 30 second continuous tone, followed by a 5 second silent interval.

To disarm the battery backed sounder, to allow for its disconnection, the following sequence must be carried out:

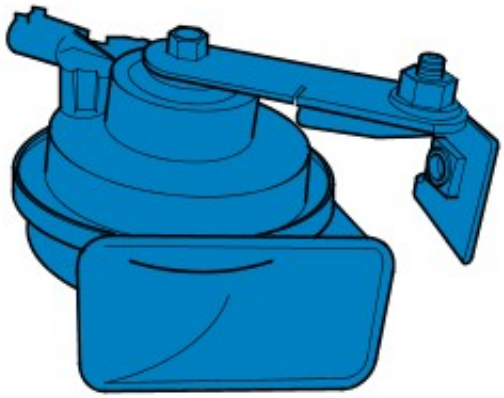
- Turn the ignition switch to position II then back to position 0,
- Disconnect the vehicle battery within 17 seconds of switching off the ignition,
- Disconnect the battery backed sounder.

If the battery backed sounder is triggered by a battery disconnection it can be reset by turning the starter switch to position II provided the remote control is on the same key ring as the key, or is in close proximity to the ignition switch.

If the battery backed sounder is triggered by the perimetric or volumetric anti-theft systems, it can be reset by either:

- pressing a button on the remote handset, or
- by turning the starter switch to position II provided the remote control is on the same key ring as the key, or is in close proximity to the ignition switch.

ANTI-THEFT ALARM HORN

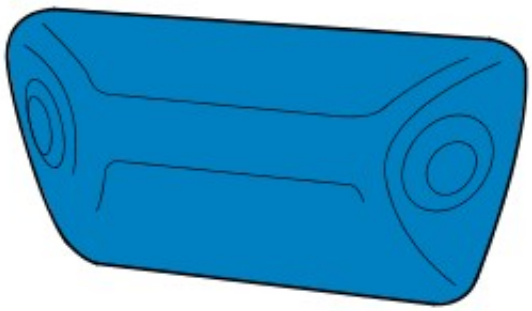


E83592

Vehicles not fitted with a battery backed sounder are fitted with an anti-theft alarm horn. The anti-theft alarm horn is located in the RH front fender, behind the headlamp. Power supply to the anti-theft alarm horn is controlled by the anti-theft system module via a relay located beneath the drivers seat.

If the anti-theft system is triggered, the anti-theft alarm horn will emit either a pulsed or continuous tone depending on market legislation.

INTRUSION DETECTION MODULE



E83593

The intrusion detection module monitors movement within the vehicle cabin. The module is located;

- at the top of the RH B pillar on 90/110 station wagons
- on the front of the headlining, adjacent the interior mirror on 90/110 pick-ups
- on the RH side of the headlining, above the front door on 130 crew cabs.

The intrusion detection module emits a series of ultrasonic sound waves. By measuring the returned sound wave the intrusion detection module can first determine a 'foot print' of the vehicle cabin, and then determine if movement has taken place within this area.

The intrusion detection module is connected directly to the anti-theft system module. If movement is detected in the cabin, the intrusion detection module provides a pulsed voltage signal to the anti-theft module, triggering the alarm.

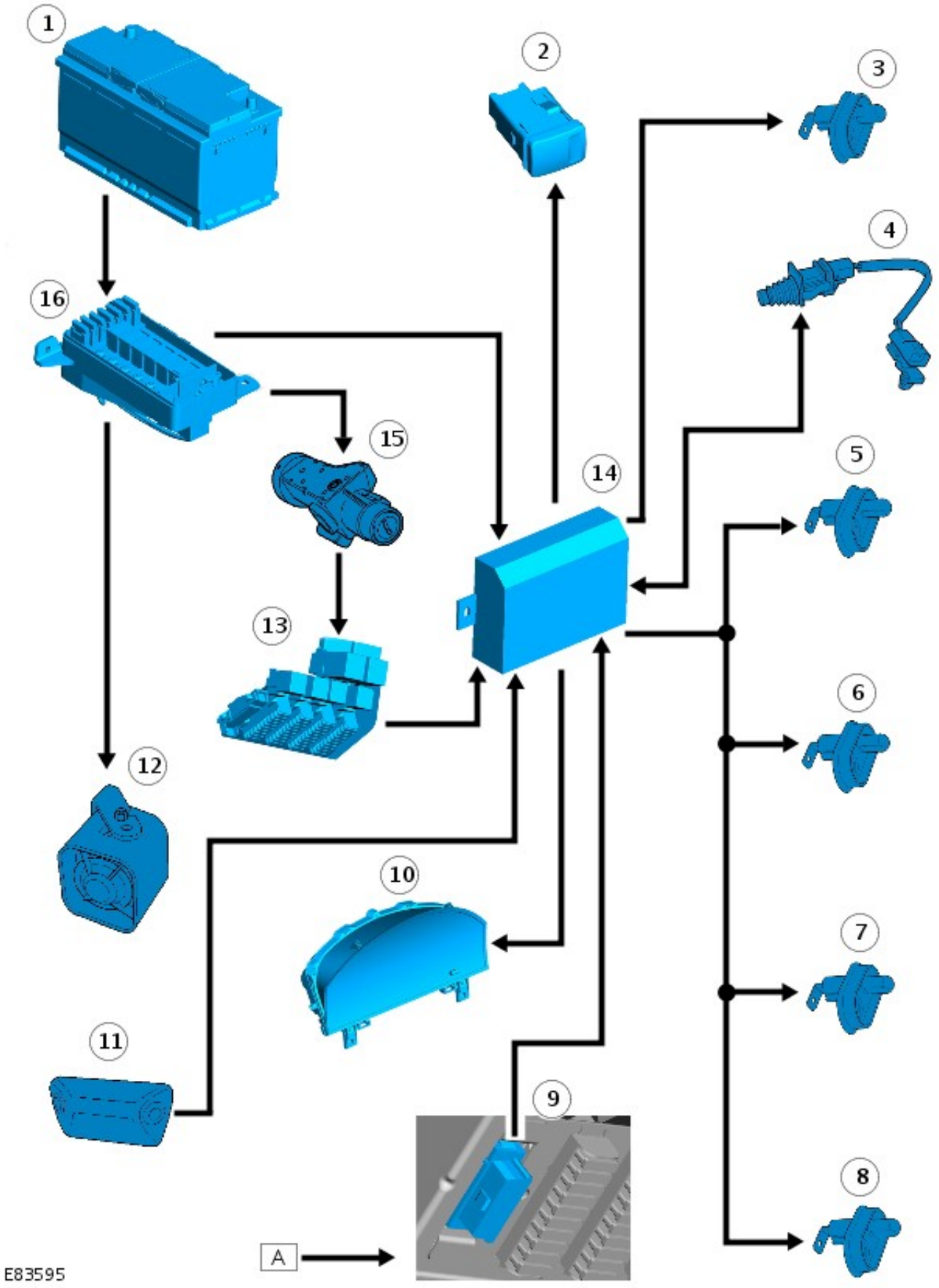
INSTRUMENT CLUSTER

Item	Part Number	Description
1	-	Anti-theft indicator

The instrument cluster contains the anti-theft indicator. The indicator provides a visual anti-theft system status. When the anti-theft system is armed, the indicator will flash quickly (8 Hz) for a 10 second period. During this period, the anti-theft system module will arm the system. After the 10 second period, the indicator will flash slowly (1 Hz), acting as a deterrent to thieves. Illumination of the anti-theft indicator is controlled by the anti-theft system module.

CONTROL DIAGRAM - BATTERY BACKED SOUNDER

- NOTE: **A** = Hardwired

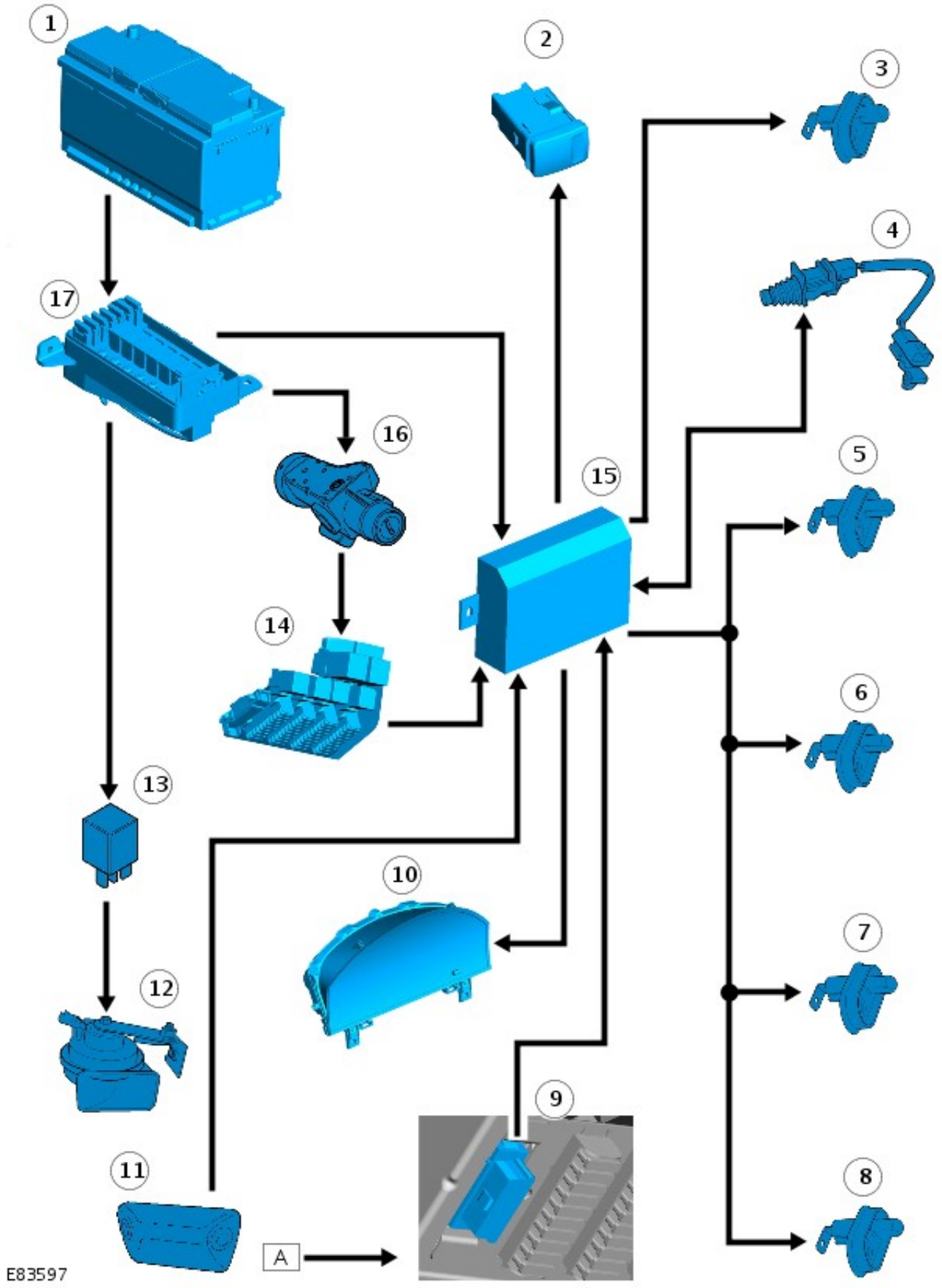


Item	Part Number	Description
1	-	Battery
2	-	Hazard flasher switch
3	-	Driver's door switch
4	-	Hood switch
5	-	Front passenger door switch
6	-	RH rear door switch (if fitted)

7	-	LH rear door switch (if fitted)
8	-	Tail door switch
9	-	Diagnostic socket
10	-	Instrument cluster
11	-	Intrusion detection module
12	-	Battery backed sounder
13	-	central junction box (CJB)
14	-	Anti-theft system module
15	-	Ignition switch
16	-	BJB

CONTROL DIAGRAM - ANTI-THEFT ALARM HORN

- NOTE: **A** = Hardwired



Item	Part Number	Description
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4	-	Hood switch
5	-	Front passenger door switch
6	-	RH rear door switch (if fitted)

7	-	LH rear door switch (if fitted)
8	-	Tail door switch
9	-	Diagnostic socket
10	-	Instrument cluster
11	-	Intrusion detection module
12	-	Anti-theft alarm horn
13	-	Anti-theft alarm horn relay
14	-	CJB
15	-	Anti-theft system module
16	-	Ignition switch
17	-	BJB

PRINCIPLES OF OPERATION

On receipt of a valid code from the remote RF handset, the anti-theft system module will arm both the perimetric and volumetric anti-theft systems. The anti-theft system module will also arm the passive immobilization system. For additional information, refer to: Anti-Theft - Passive (419-01B Anti-Theft - Passive, Description and Operation). Once armed, the anti-theft system can be triggered up to 3 times in any one arming cycle.

Perimetric Protection

Perimetric protection is the monitoring of each hinged panel, namely the doors, tail door and hood, for unauthorized entry. The anti-theft system module monitors the condition of each hinged panel through a series of hardwired connections.

The driver's door switch and the hood switch are connected to the anti-theft system module on individual wires. The remaining hinged panels are wired in parallel and connected to the anti-theft system module on a single wire.

All the switches are open circuit. If a hinged panel is opened, the switch contacts close and a ground path is generated. The switch ground paths are through the vehicle body, except for the hood switch which is provided a ground path via the anti-theft system module. When the anti-theft system module registers a ground path it determines a hinged panel has been opened and triggers the alarm.

Volumetric Protection

Volumetric protection monitors movement within the cabin. When the system is first armed, the anti-theft module suspends volumetric protection for 15 seconds. This allows air in the cabin to settle and prevents nuisance triggers. The anti-theft system module monitors movement in the vehicle cabin using the intrusion detection module. The anti-theft system module will not initiate volumetric protection unless the intrusion detection module detects no disturbances for 15 seconds. If, during the 15 second arming period movement is detected, the 15 second period will re-start from 0.

Volumetric protection can be disabled in one of two ways:

- By locking the vehicle with the key in the driver's door rather than using the remote RF handset.
- By locking the vehicle with the remote RF handset while the driver's door is open. If the driver's door is subsequently shut, only the perimetric system will be armed.

Visual Indications

• NOTE: Visual and audible warnings are dependent on market legislation.

When the anti-theft system is armed the anti-theft system module will flash the hazard flashers 3 times. The hazard flashers are controlled by 2 outputs from the anti-theft system module; one for the LH lamps, one for the RH lamps. To illuminate the hazard flashers, the output from the anti-theft system module is at battery voltage. To extinguish the lamps, the output is driven to ground.

The anti-theft system module will also control operation of the instrument cluster indicator. The module will flash the indicator at a rate of 8 Hz for 10 seconds, followed by a 1 Hz flashing rate.

If the anti-theft system is triggered, the anti-theft system module will flash the hazard flashers for 30 seconds at 0.5 second intervals.

Audible Indications

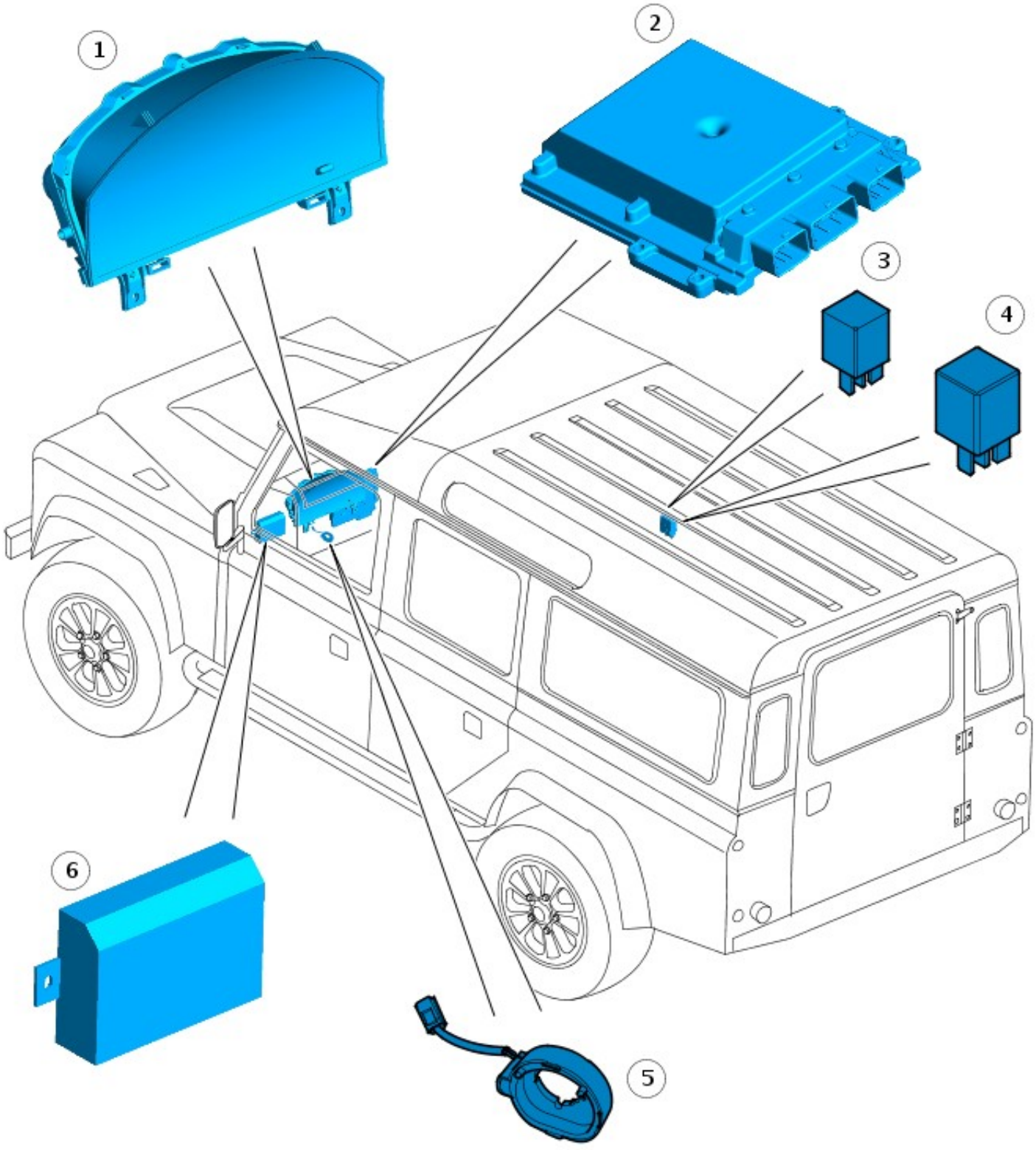
If the anti-theft system is triggered, the anti-theft system module will activate the sounder. Depending on market legislation, the sounder is either an anti-theft alarm horn or a battery backed sounder. Again, depending on market legislation, the sounder may emit either a continuous or pulsed tone.

The anti-theft system module provides a battery voltage feed to, depending on vehicle specification, the battery backed sounder or the anti-theft alarm horn relay. To power the sounder, the anti-theft system module removes the feed and provides a ground path.

Anti-Theft - Passive - Anti-Theft - Passive

Description and Operation

COMPONENT LOCATION



E87499

Item	Part Number	Description
1	-	Instrument cluster

2	-	engine control module (ECM)
3	-	Starter relay
4	-	Glow plug relay
5	-	Transceiver coil
6	-	Anti-theft system module

OVERVIEW

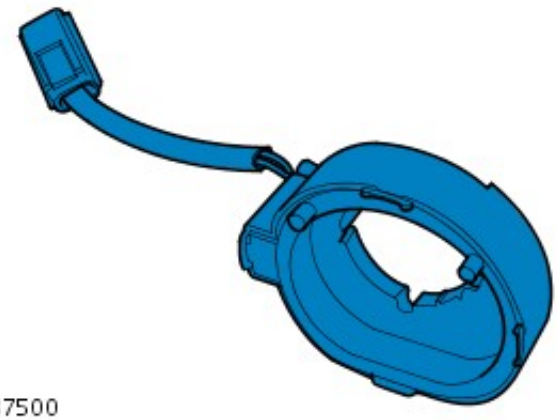
The 10AS anti-theft system works in conjunction with the ECM to control the passive anti-theft system. The passive anti-theft system immobilizes the engine by inhibiting the starter relay and fuel injectors until a valid code is received from the remote Radio Frequency (RF) handset.

The passive anti-theft system features 2 levels of protection:

- Engine immobilization only
- Engine immobilization plus perimetric and volumetric anti-theft alarm protection.
  For additional information, refer to: Anti-Theft - Active (419-01A Anti-Theft - Active, Description and Operation).

The anti-theft system module activates the engine immobilization system 30 seconds after the key is removed from the ignition switch and the driver's door is opened. If the key is removed from the ignition switch and the drivers door isn't opened, the anti-theft system module will activate the engine immobilization system after a period of 5 minutes.

TRANSCEIVER COIL


E87500

The transceiver coil comprises a coil mounted around the ignition barrel. When the ignition switch is turned to position II, the anti-theft system module provides a permanent battery voltage feed and a pulsed voltage feed to the transceiver coil. This creates a magnetic field around the ignition barrel, which collapses and restores in relation to the pulsed power feed from the anti-theft system module. The fluctuating magnetic field activates the remote RF handset which transmits a mobilization signal.

ANTI-THEFT SYSTEM MODULE

E83589

The anti-theft system module is located behind the instrument cluster and works in conjunction with the ECM to control the passive anti-theft system. The anti-theft system module receives a permanent battery supply from the battery junction box (BJB) and an ignition switch supply from the central junction box (CJB).
For additional information, refer to: Battery and Cables (414-01 Battery, Mounting and Cables, Description and Operation).

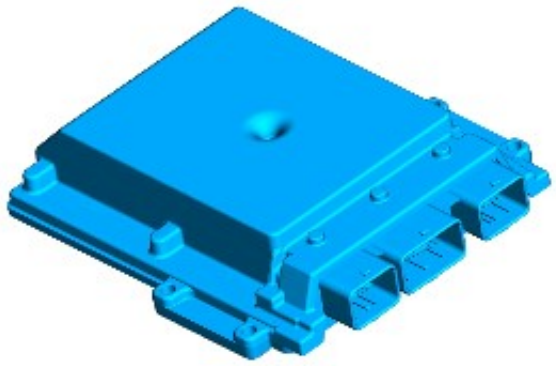
A mobilization code is transmitted to the anti-theft system module by the remote RF handset. The mobilization code is received via the anti-theft system module antenna, which hangs below the module. The anti-theft system module determines if a valid code is received from the remote RF handset by comparing the received code with one stored in its

memory.

The anti-theft system module also controls;

- the active anti-theft system.
  For additional information, refer to: Anti-Theft - Active (419-01A Anti-Theft - Active, Description and Operation).
- the central locking system.
  For additional information, refer to: Handles, Locks, Latches and Entry Systems (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).
- interior lighting.
  For additional information, refer to: Interior Lighting (417-02 Interior Lighting, Description and Operation).
- the hazard flashers.
  For additional information, refer to: Exterior Lighting (417-01 Exterior Lighting, Description and Operation).

ENGINE CONTROL MODULE

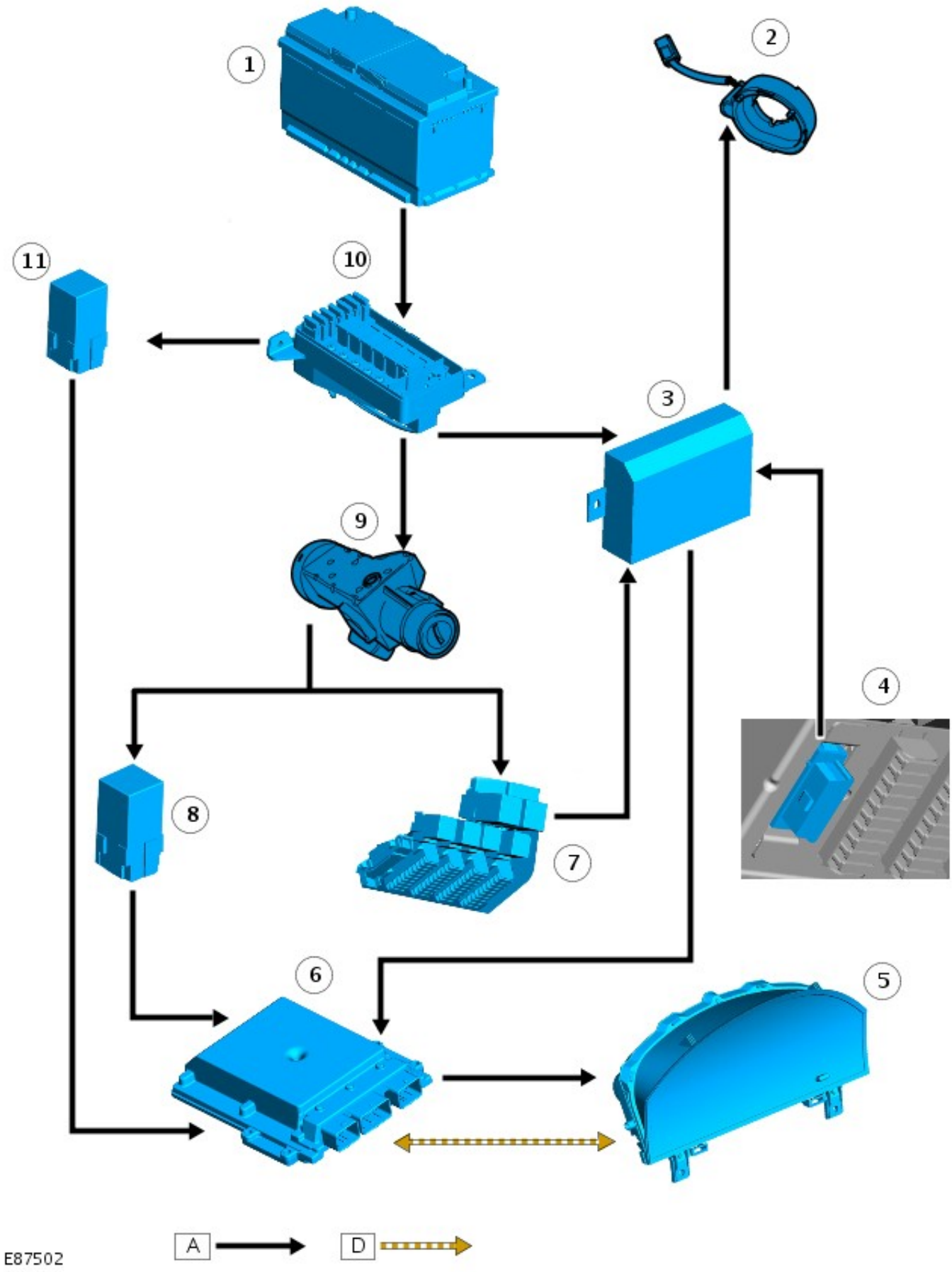


E87501

The ECM is mounted on the engine compartment bulkhead and works in conjunction with the anti-theft system module to control the passive anti-theft system.
For additional information, refer to: Electronic Engine Controls (303-14 Electronic Engine Controls - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Description and Operation).

CONTROL DIAGRAM

• NOTE: **A** = Hardwired; **D** = High speed controller area network (CAN) bus



Item	Part Number	Description
1	-	Battery
2	-	Transceiver coil
3	-	Anti-theft system module
4	-	Diagnostic socket
5	-	Instrument cluster
6	-	ECM

7	-	CJB
8	-	Starter relay
9	-	Ignition switch
10	-	BJB
11	-	Glow plug relay

PRINCIPLES OF OPERATION

The anti-theft system module receives a permanent battery supply from fuse 7 in the BJB. When the vehicle key is placed in the ignition barrel and turned to position II (ignition on), the anti-theft system module will also receive a power supply from fuse 8 of the CJB.

When the anti-theft system module receives the ignition switch feed it activates the transceiver coil by supplying a battery voltage feed from pin 12 of connector C0057, and a pulsed voltage signal from pin 7 of connector C0057.

The pulsed feed from the anti-theft system module causes the magnetic field created by the transceiver coil to collapse and restore. The fluctuating magnetic field activates the remote RF handset to transmit a mobilization code to the anti-theft system module.

The anti-theft system module receives the mobilization code via its antenna. This code is compared to a value in its memory. If the codes match, the anti-theft system module provides a mobilization signal to the instrument cluster. The instrument cluster acts as a gateway, converting the signal transmitted from the anti-theft system module into a signal that is recognizable by the ECM. This signal is then transmitted by the instrument cluster to the ECM which will energize the starter relay and the fuel injectors to allow the engine to be started.

Emergency Key Access

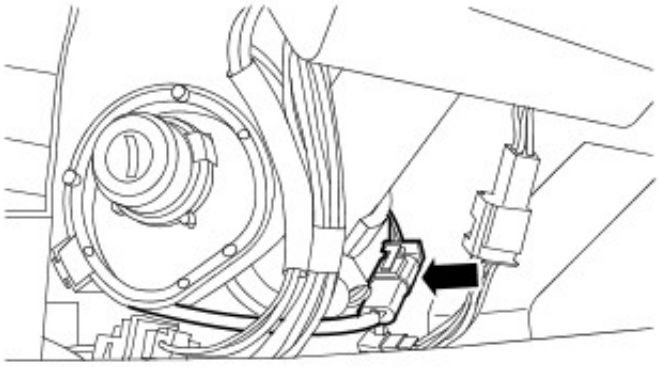
If the vehicle is immobilized and the remote RF handset is not available, the emergency key access procedure will allow the engine to be mobilized using the vehicle key. For information on the emergency key access feature, refer to the Owners Handbook.

Anti-Theft - Passive - Passive Anti-Theft System (PATS) Transceiver

Removal and Installation

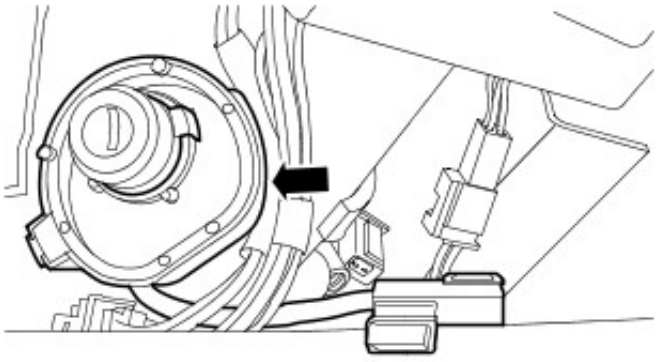
Removal

1. Remove the steering column shrouds.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect the passive anti-theft system (PATS) transceiver electrical connector.



E90130

3. Remove the PATS transceiver.



E90131

Installation

1. To install, reverse the removal procedure.

5: Body and Paint

Front End Body Panels - Fender
Removal and Installation

Removal

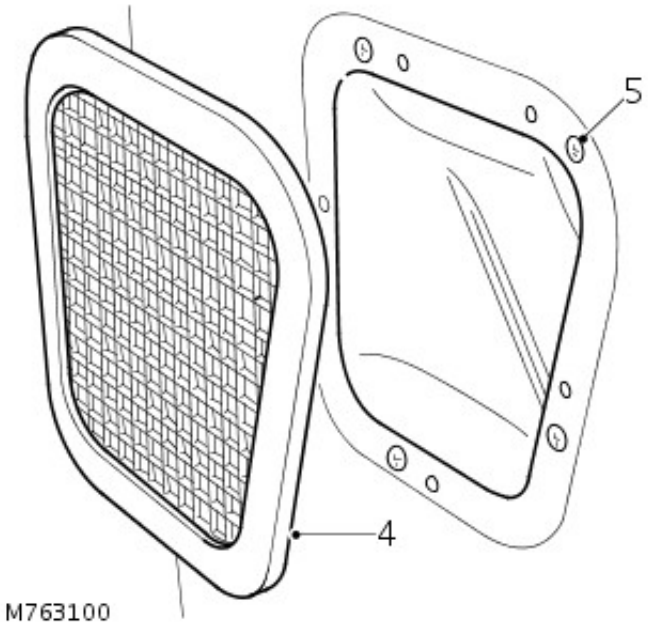
1. Remove fender splash shield.
For additional information, refer to: Fender Splash Shield (501-02 Front End Body Panels, Removal and Installation).

2. Remove radiator grille.
For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).

3. Release fixings and remove cooling fan shroud.

4. Remove air cleaner grille from front fender.

5. Remove 4 screws securing air intake elbow to fender.

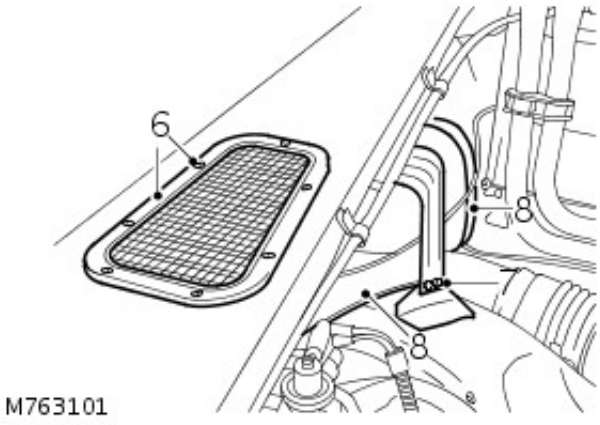


M763100

6. Remove 7 screws and remove heater air intake grille from fender.

7. Remove 2 bolts securing heater air intake bracket to inner fender. Remove bracket.

8. Remove heater air intake from fender and collect seal.



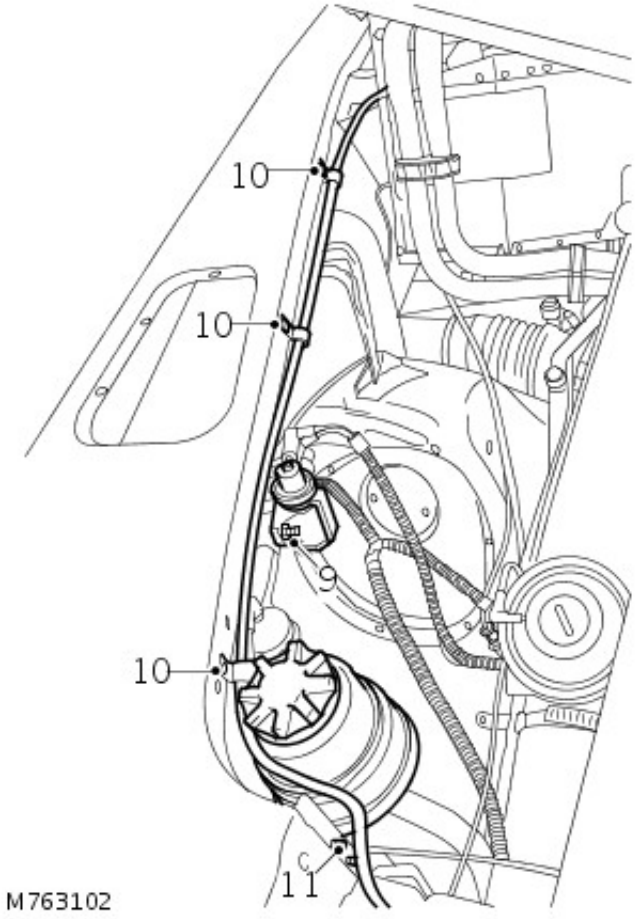
M763101

9. Remove 2 bolts securing EGR solenoid to inner fender and lay aside.

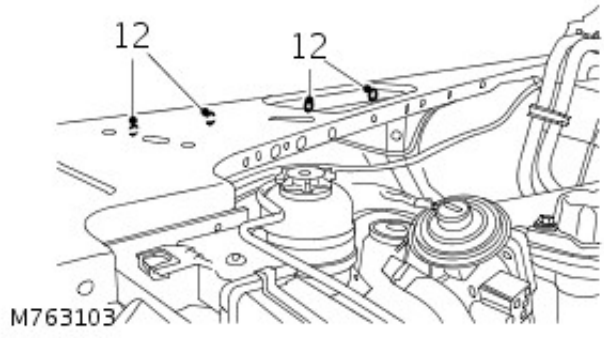
10. Remove 3 studs securing expansion tank pipe to inner fender.

11. Remove 2 bolts securing PAS reservoir to inner fender

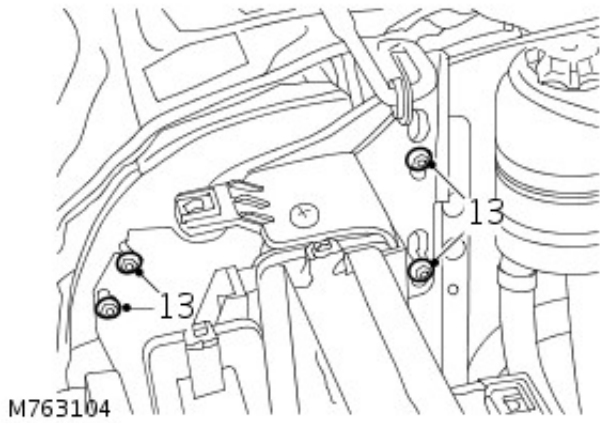
and lay aside.



12. Remove 4 bolts securing outer fender to inner fender.

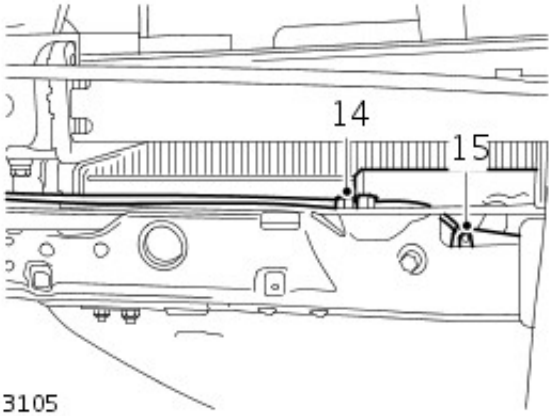


13. Remove 4 bolts securing radiator mounting bracket to fender.



14. Loosen screw and release hood lock inner cable from hood lock.

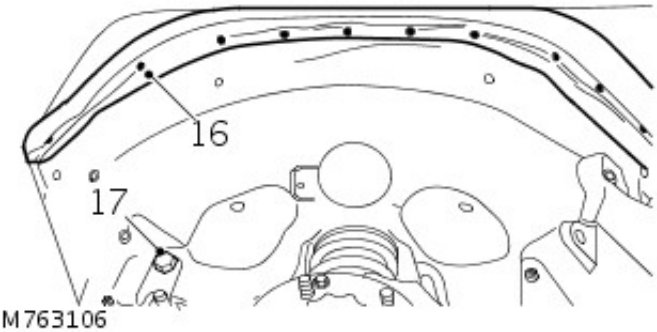
15. Release hood lock outer cable from hood lock.



M763105

16. Push centre pins from studs securing wheel arch extension to fender, remove studs and remove wheel arch extension.

17. Remove bolt securing inner and outer fender to chassis.

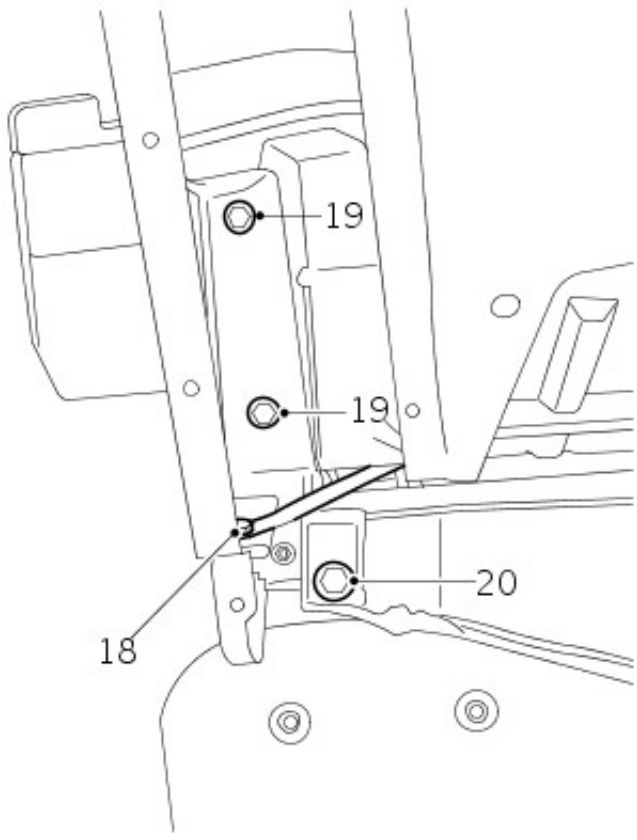


M763106

18. Remove nut and bolt securing support stay to fender.

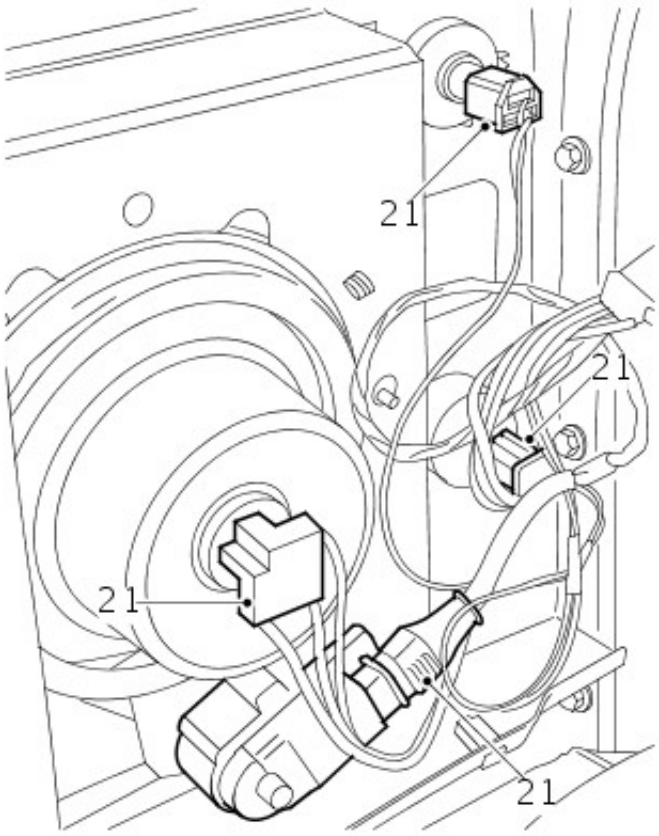
19. Remove 4 bolts securing fender to 'A' post.

20. Remove bolt securing fender to bulkhead.



M763107

21. Disconnect headlamp, side lamp, repeater and side turn lamp multiplugs.



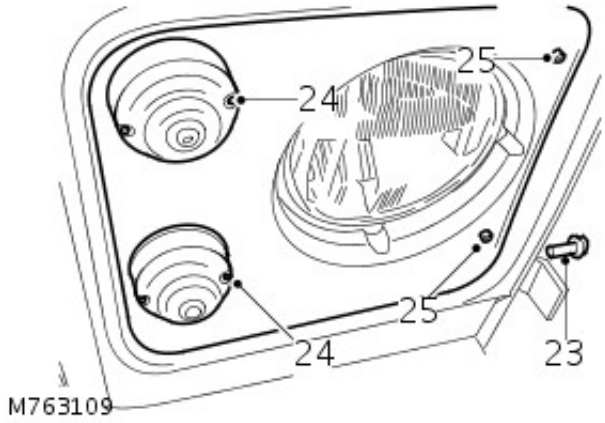
M763108

22. With assistance, remove fender.

23. Remove bolt, remove grille support bracket.

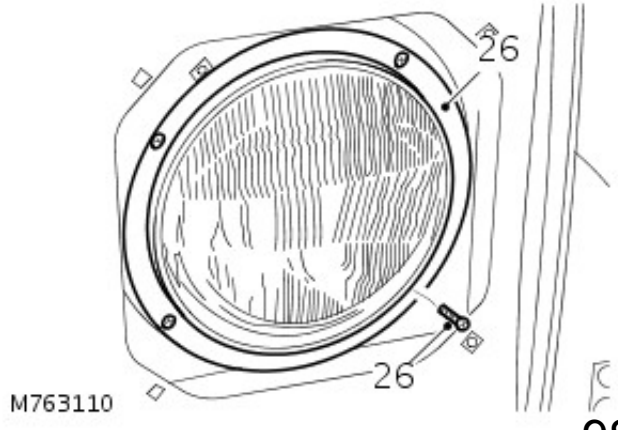
24. Remove 4 screws securing side lamp and side turn lamp.

25. Remove 2 screws securing headlamp finisher to fender, remove finisher.



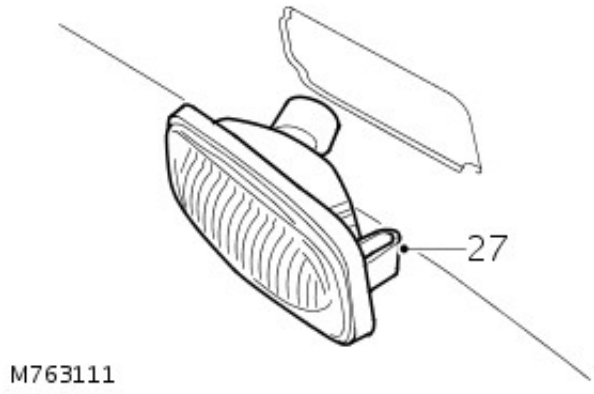
M763109

26. Remove 4 screws and remove headlamp from fender, collect sealing ring.

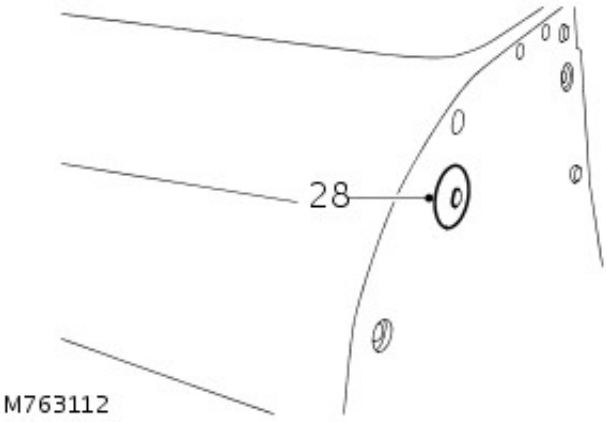


M763110

27. Release side repeater lamp from fender.



28. Remove hood cable grommet.



Installation

1. Fit hood cable grommet.

2. Fit side repeater lamp to fender.

3. Fit headlamp sealing ring, fit headlamp and tighten screws.

4. Fit headlamp finisher, side lamp and side turn lamps and tighten screws.

5. Fit grille support bracket and tighten bolt.

6. With assistance, position and align fender to body and locate hood cable to fender.

7. Connect headlamp, side lamp, side turn lamp and side repeater lamp multiplugs.

8. Fit bolt securing fender to bulkhead.

9. Fit bolts securing fender to 'A' post.

10. Fit nut and bolt securing support stay to fender.

11. Fit bolt securing inner and outer fender to chassis.

12. Fit bolts securing radiator bracket to fender.

13. Fit bolts securing outer fender to inner fender.

14. Align fender and finally tighten all bolts.

15. Position wheel arch extension to fender, and fit securing studs.

16. Position PAS reservoir to fender and tighten bolts.

17. Position expansion tank pipe and secure with studs.

18. Position EGR solenoid and tighten bolts.

19. Position heater air intake seal and fit air intake.

20. Fit heater air intake bracket and tighten bolts.

21. Fit heater air intake grille and tighten screws.

22. Align air cleaner intake elbow, tighten screws and fit grille.

23. Fit fender splash shield.
For additional information, refer to: Fender Splash Shield

(501-02 Front End Body Panels, Removal and Installation).

24. Position hood release cable to lock and tighten screw.

25. Fit cooling fan shroud.

26. Fit radiator grille.
For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).

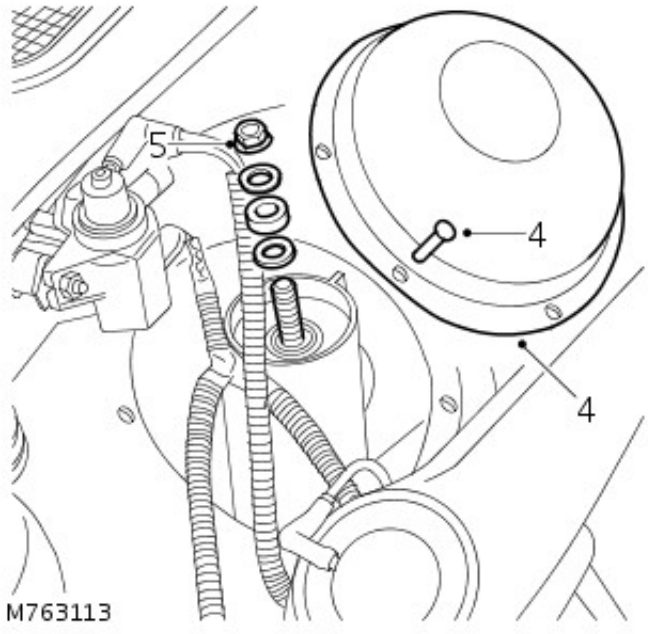
Front End Body Panels - Fender Splash Shield

Removal and Installation

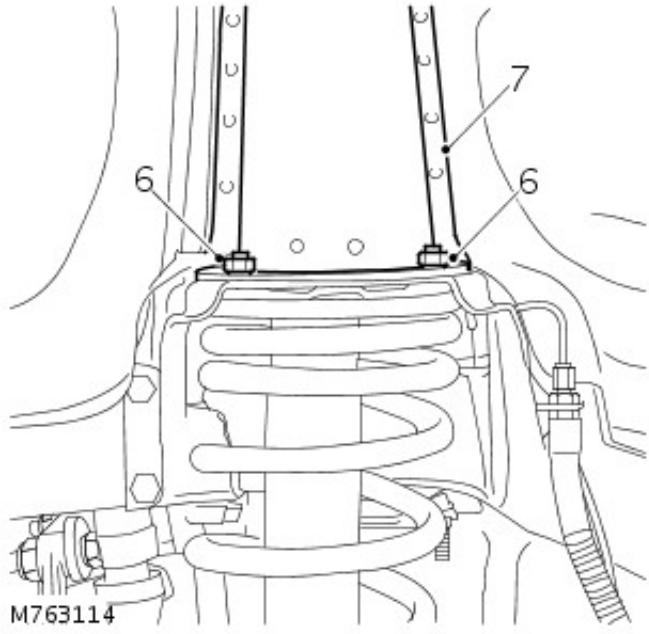
Removal

1. WARNING: Support on safety stands.

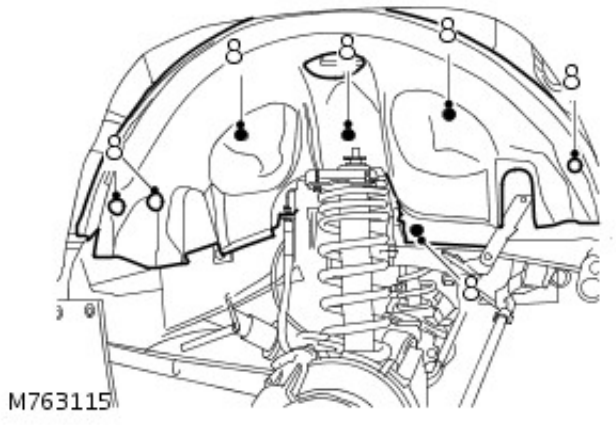
   Raise front of vehicle.
2. Remove front wheel.
3. Support axle weight with jack.
4. Remove 6 screws securing damper top cover to inner wing, remove cover.
5. Remove nut securing damper to top mounting bracket and collect rubber bush and 2 washers.



6. Remove 4 nuts securing damper to mounting bracket and collect washers.
7. Remove damper top cover.



8. Remove 4 screws and 3 studs securing fender splash shield



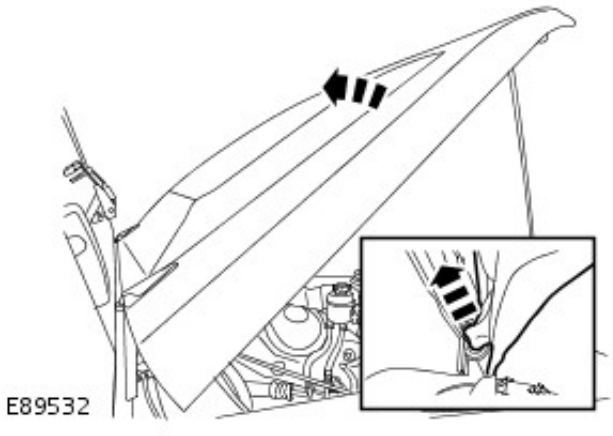
to inner wing. Remove fender splash shield.

Installation

1. Position fender splash shield, secure with screws and studs.
2. Fit damper mounting bracket and tighten nuts.
3. Position damper to mounting bracket, fit rubber bush and washers and tighten nut.
4. Fit damper cover to inner wing and secure with screws.
5. Fit road wheel.
6. Remove stands and lower vehicle.

Front End Body Panels - Hood
Removal and Installation

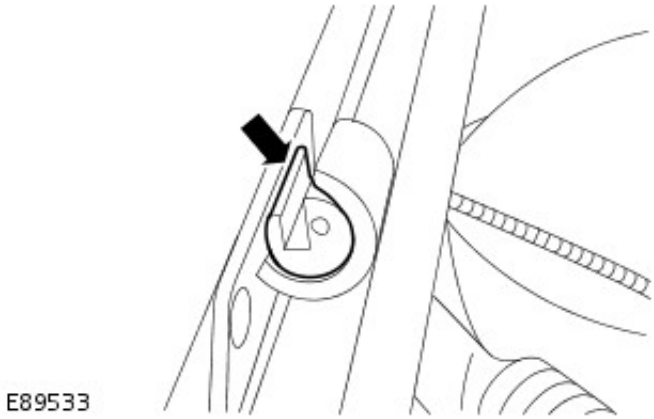
Removal



1. Remove the hood.

- With assistance, remove the hood in an upwards direction.

Installation

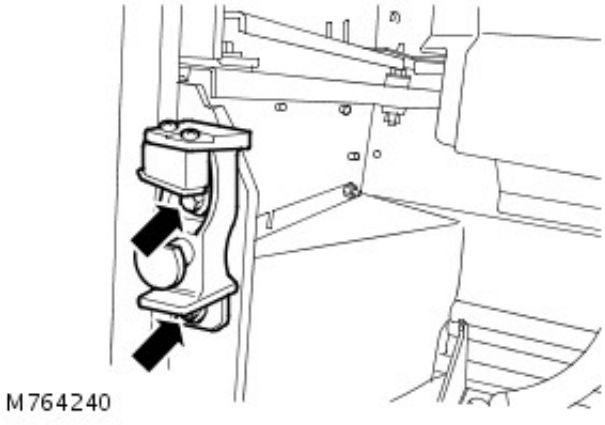


1. To install, reverse the removal procedure.

- Make sure the hood guides are inline with the hinge bracket.

Body Closures - Taildoor Striker Adjustment

General Procedures



1. NOTE: Before adjusting the taildoor striker, ensure the spare wheel is fitted to taildoor.

Loosen screws securing taildoor striker.

2. Adjust taildoor striker and tighten screws.

3. Close taildoor and check for correct latching with taildoor lock.

4. Carry out further adjustment as necessary. If full adjustment cannot be achieved carry out following.

5. Remove taildoor striker and nut plate.

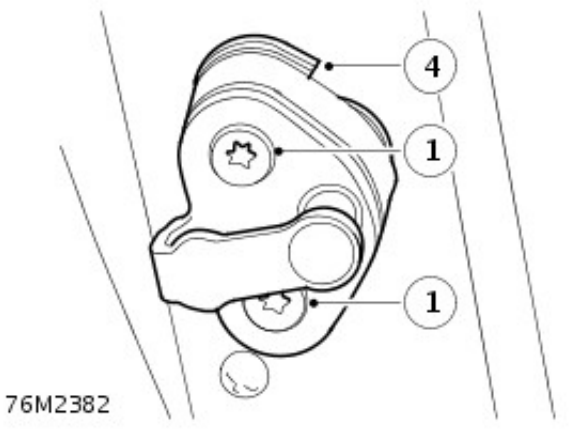
6. Elongate holes in body metal which is sandwiched between taildoor striker and nut plate.

7. Refit taildoor striker and adjust as necessary.

Body Closures - Door Striker Adjustment

General Procedures

• NOTE: This procedure covers adjustment of striker on front and rear doors.



1. Loosen Torx bolts securing striker to B-pillar or C-pillar.

2. Adjust alignment of striker vertically and horizontally, lightly tighten bolts.

3. Close door, check for correct latching with door lock and for centering on striker.

4. Add or remove packing shims as necessary. Fully tighten bolts.

5. Carry out further adjustment as necessary. If full adjustment cannot be achieved carry out following:

6. Remove striker and nut plate.

7. Elongate striker bolt holes in B-pillar or C-pillar to increase movement in direction required.

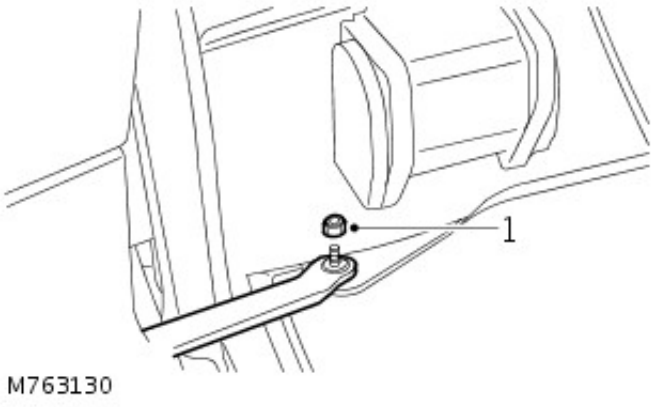
8. Refit striker and adjust as necessary.

Body Closures - Door

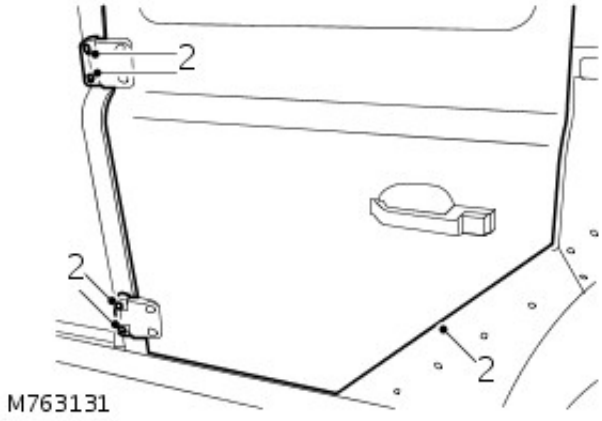
Removal and Installation

Removal

1. Remove nut securing door check strap.



2. With assistance remove 4 bolts securing door to body and remove door.



Installation

1. With assistance position door and fit but do not tighten bolts.

2. Align door to body aperture and tighten bolts.

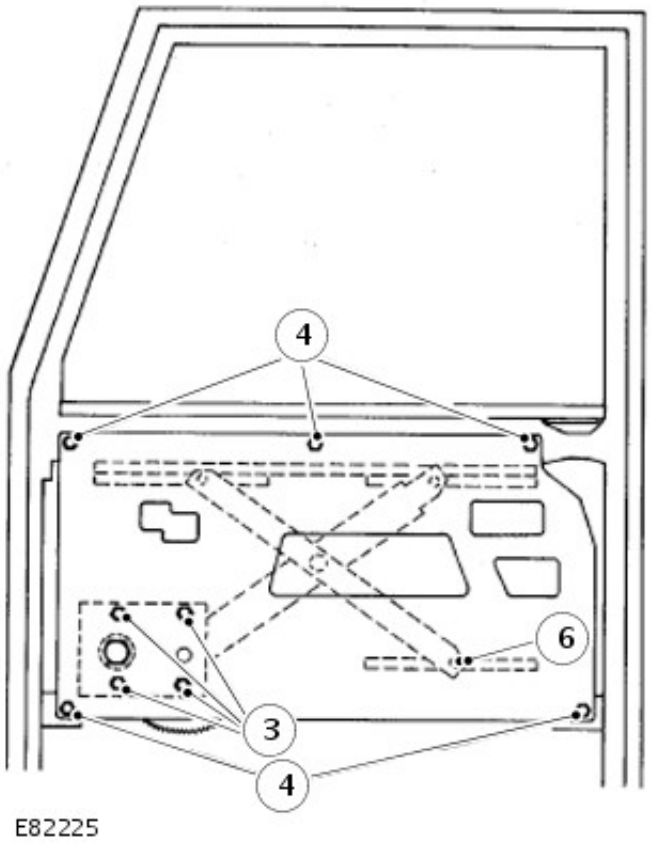
3. Fit and tighten check strap nut.

Body Closures - Front Door Reinforcement Panel

Removal and Installation

Removal

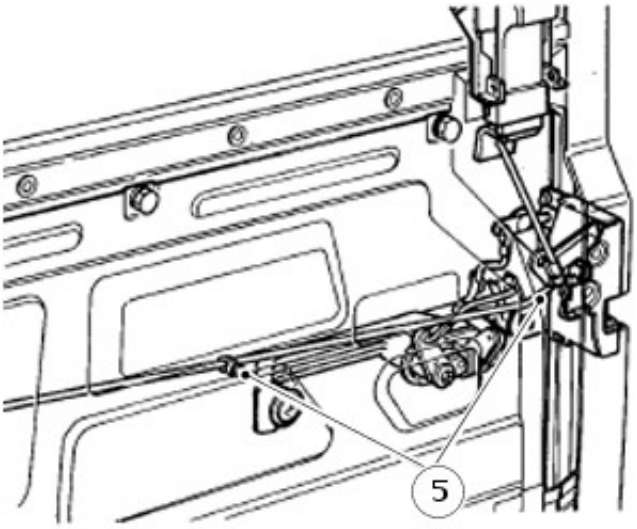
1. Remove door trim panel and plastic sheet.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Remove plastic sheet.
3. Remove 4 screws securing window regulator to mounting panel.
4. Remove 5 screws securing mounting panel to door frame.



E82225

5. Release remote control lever rod from latch mechanism and from plastic clip in mounting panel.
6. Slide window regulator arm from mounting panel channel

and remove panel with remote control lever and rod.



E82226

Installation

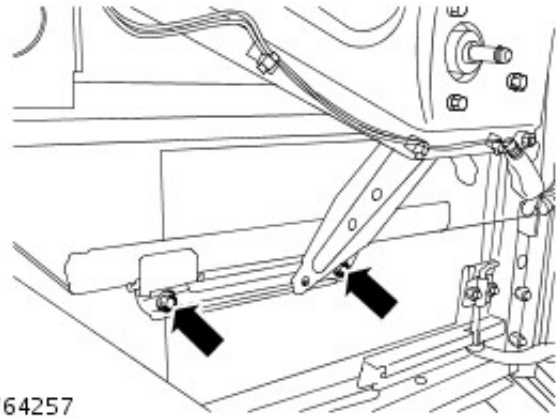
1. Engage window regulator arm in mounting panel channel.
2. Connect remote control rod to latch mechanism and secure with clip.
3. Install mounting panel and retain with 5 screws.
4. Secure window regulator to mounting panel with 4 screws.
5. Raise and lower window to check for free movement.
6. Install plastic sheet, and door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Body Closures - Rear Door Reinforcement Panel

Removal and Installation

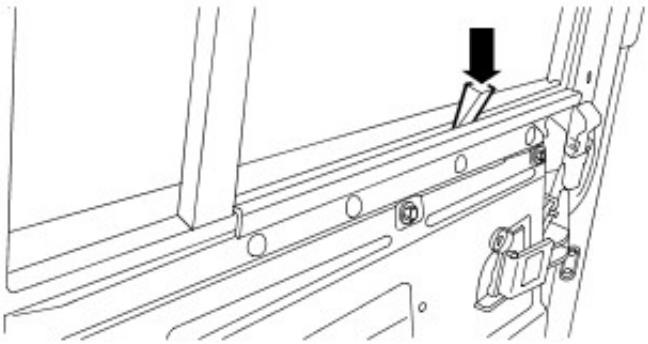
Removal

1. Remove rear door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Remove plastic sheet from the door.
3. Lower the glass and remove 2 bolts securing door glass to regulator.



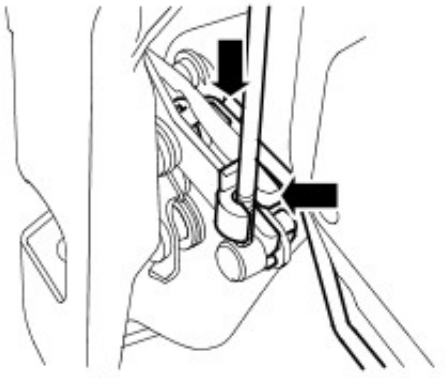
M764257

4. Release glass from regulator, raise and wedge in raised position.



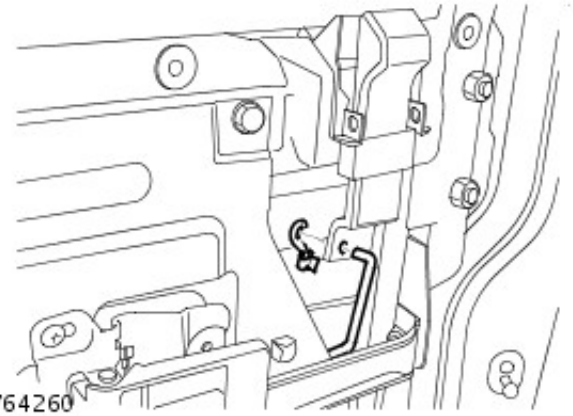
M764258

5. Release clip, detach and remove door lock motor link.

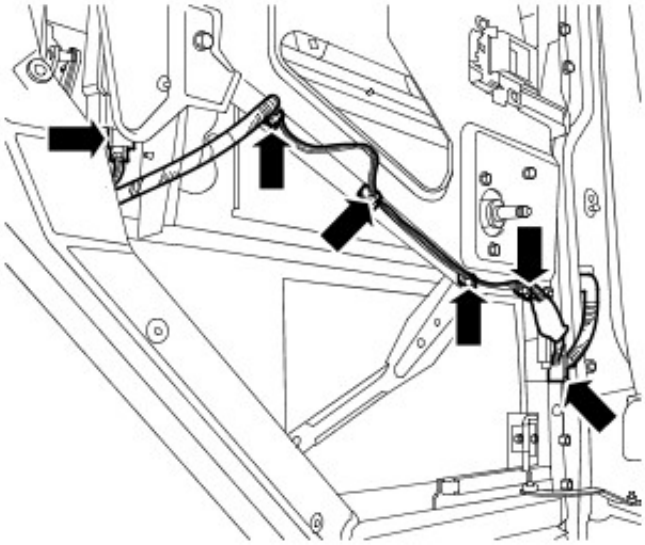


M764259

6. Release clip and disconnect interior handle link from latch mechanism.
7. Remove clip and disconnect push button link.


M764260

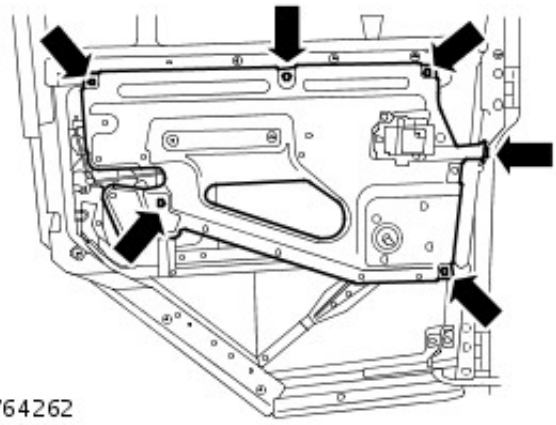
8. Release clips securing harness to door reinforcement panel.


M764261

9. Disconnect multiplug from door lock motor.

10. Release harness sleeve and withdraw harness from door.

11. Remove 5 bolts and 1 nut securing door reinforcement panel.


M764262

12. Remove door reinforcement panel.

Installation

1. Position door reinforcement panel assembly, fit bolts and nut and tighten to 10 Nm (7lbf.ft).

2. Connect multiplug to door lock motor.

3. Secure harness clips and sleeve.

4. Connect interior handle link to latch and secure with clip.

5. Connect link to push button and fit clip.

6. Fit and secure door lock motor link.

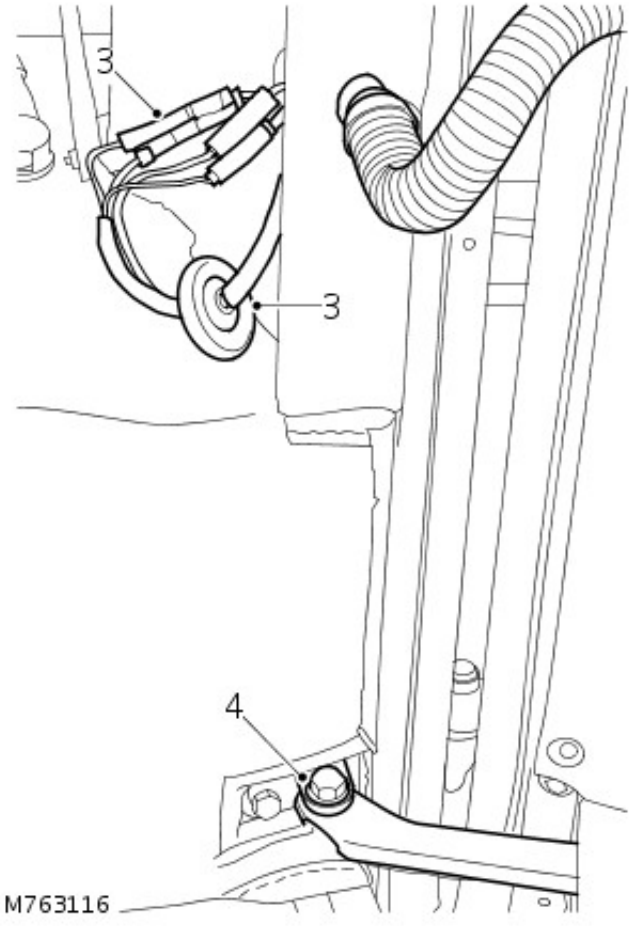
7. Remove wedges, lower the glass and locate to regulator. Fit bolts and tighten to 6 Nm (4 lbf.ft).
8. Raise and lower glass to check operation.
9. Fit plastic sheet to the door.
10. Fit rear door trim panel.
    For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Body Closures - Taildoor

Removal and Installation

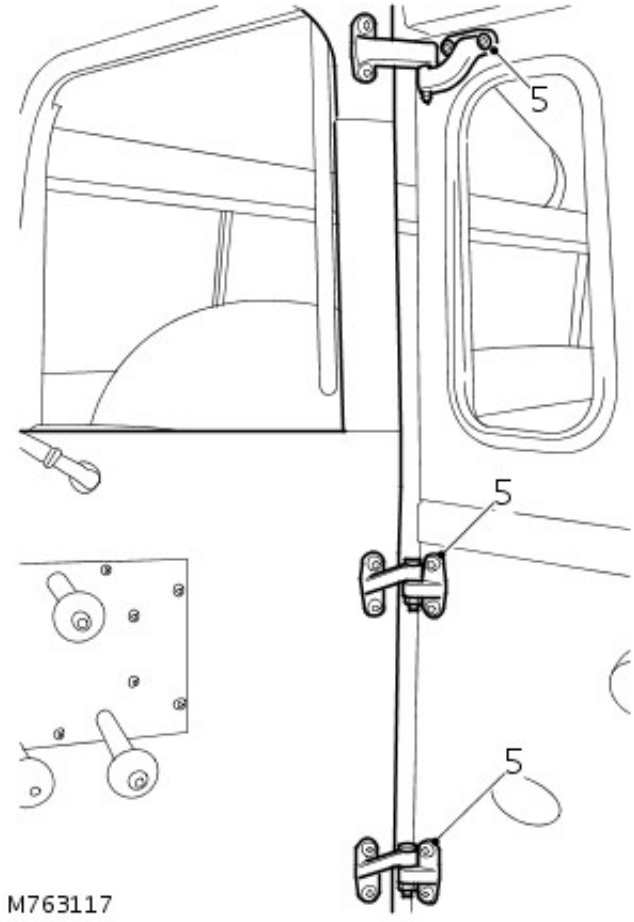
Removal

1. Remove 3 nuts and remove spare wheel.
2. Remove bolt securing check strap to body.
3. Release harness grommet from harness cover, disconnect connectors and multiplug.
4. Release harness cover and harness from body.



5. With assistance, remove 6 screws securing taildoor hinges

to body and remove taildoor.

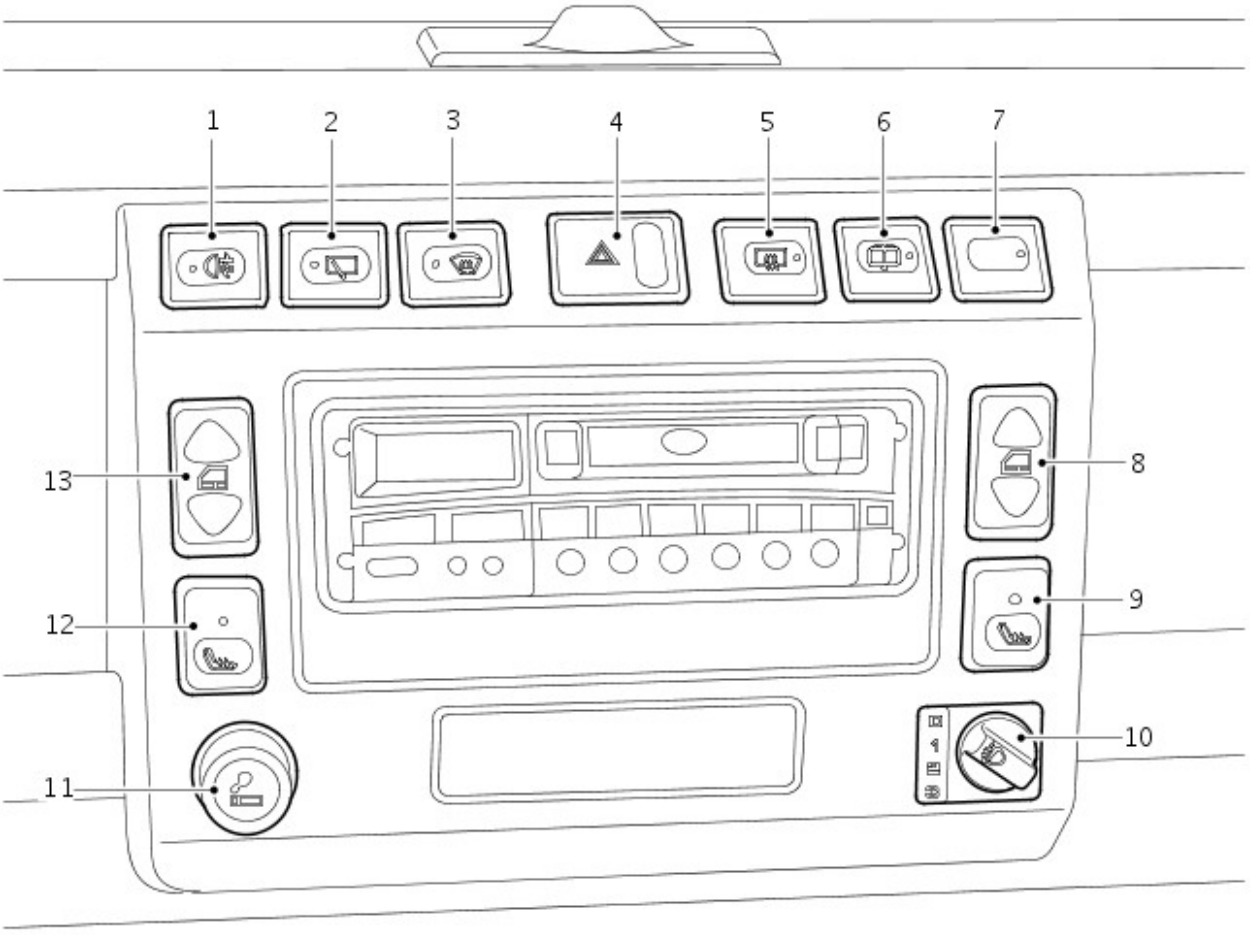


Installation

1. With assistance, position taildoor and fit but do not tighten bolts.
2. Position check strap and tighten bolt.
3. Align taildoor to body and tighten bolts.
4. Position harness through body and secure harness cover.
5. Secure harness connectors and multiplug.
6. Secure harness grommet to body.
7. Position spare wheel to taildoor and tighten nuts.
8. Adjust taildoor striker.
   For additional information, refer to: Taildoor Striker Adjustment (501-03 Body Closures, General Procedures).

Interior Trim and Ornamentation - Interior Trim
Description and Operation

Fascia Console



M865561A

Item	Part Number	Description
1	-	Rear fog lamp switch
2	-	Rear wiper switch
3	-	Heated front screen switch (if fitted)
4	-	Hazard warning lamp switch
5	-	Heated rear window switch
6	-	Rear washer switch
7	-	Front fog lamps switch (if fitted)
8	-	RH front window switch
9	-	RH heated front seat switch (if fitted)
10	-	Headlamp levelling control switch
11	-	Cigar lighter (if fitted)
12	-	LH heated front seat switch (if fitted)
13	-	LH front window switch

The console comprises a plastic moulding secured to the fascia with five screws. The new console allows existing switches to be repositioned and has provided the opportunity to commonise the switches with other Land Rover models.

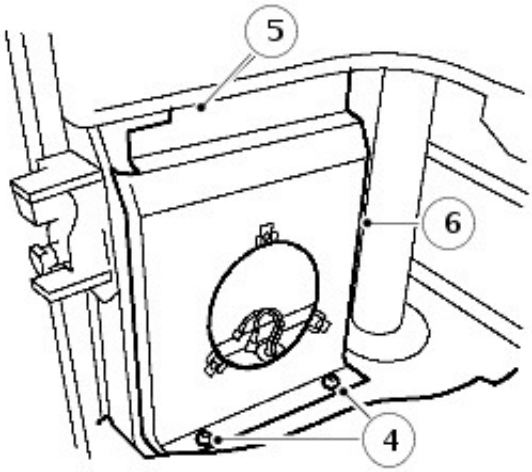
A central cut-out in the console provides for the installation of the radio, where fitted, or a coin tray for markets without a standard radio installation.

Interior Trim and Ornamentation - Cowl Side Trim Panel

Removal and Installation

Removal

1. Raise the seat cushion and fit stowage strap.
2. Remove the rear quarter trim panel.
   For additional information, refer to: Rear Quarter Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Remove the rear door speaker.
   For additional information, refer to: Rear Door Speaker (415-03 Speakers, Removal and Installation).
4. Peel back carpet and remove 2 screws securing cowl side trim panel to wheel arch.
5. Prise top edge of cowl side trim panel down to release from body channel.
6. Remove the cowl side trim panel.



J6051

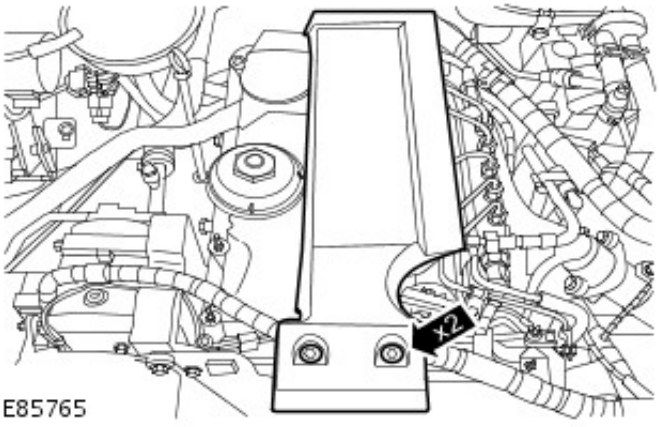
Installation

1. Position the cowl side trim panel on wheel arch.
2. Press top edge of cowl side trim panel down firmly and locate under body channel.
3. Secure cowl side trim panel to wheel arch with screws and reposition carpet.
4. Fit the rear door speaker.
   For additional information, refer to: Rear Door Speaker (415-03 Speakers, Removal and Installation).
5. Fit the rear quarter trim panel.
   For additional information, refer to: Rear Quarter Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Interior Trim and Ornamentation - Engine Cover

Removal and Installation

Removal



1. NOTE: Note the routing of the engine wiring harness.

Remove the engine cover.

- Remove the 2 bolts.

Installation

1. NOTE: Make sure the engine wiring harness is routed correctly.

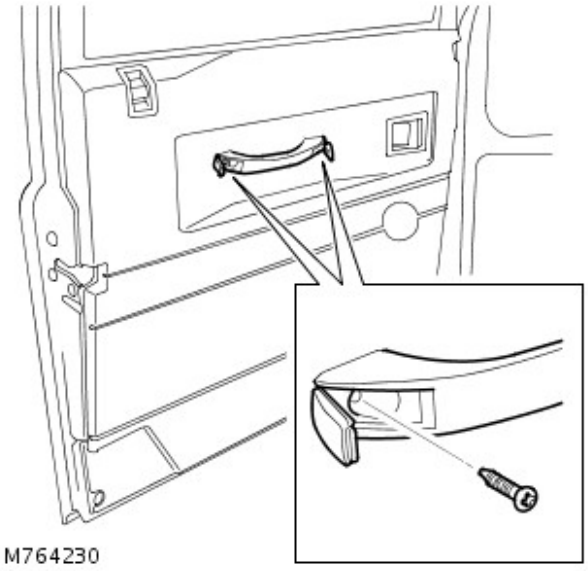
To install, reverse the removal procedure.

Interior Trim and Ornamentation - Front Door Trim Panel

Removal and Installation

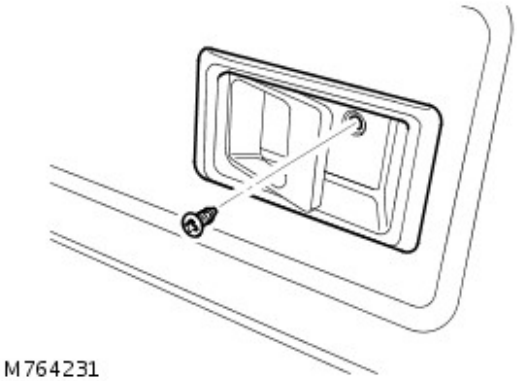
Removal

1. Remove 2 screws securing door pull and remove door pull.



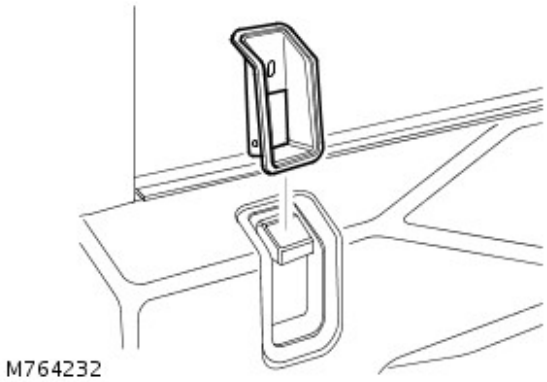
M764230

2. Remove screw securing door release escutcheon and remove escutcheon.



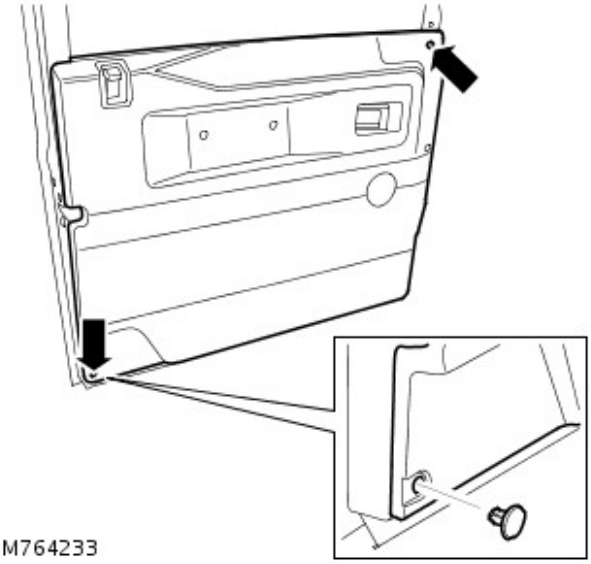
M764231

3. Remove sill button guide.



M764232

4. Remove 2 studs securing trim casing.

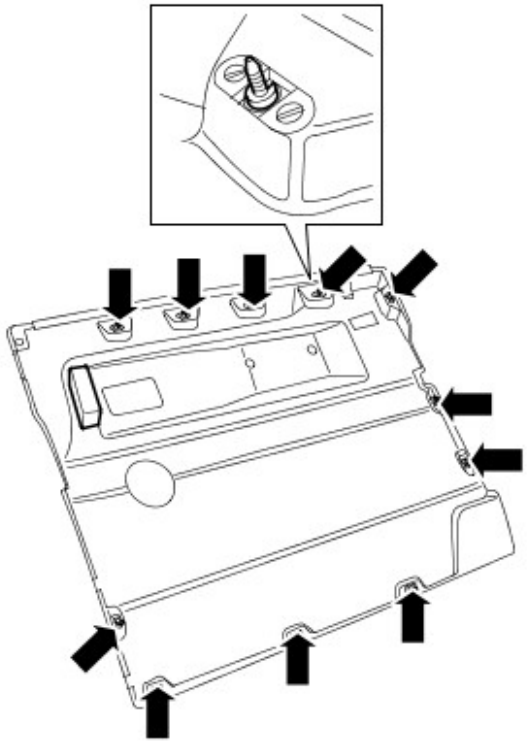


M764233

5. Using a trim removal tool, release 11 fasteners and remove trim casing.

6. NOTE: Do not carry out further dismantling if component is removed for access only.

Remove fasteners and anti-vibration pad from trim casing



M764234

Installation

1. Instal anti-vibration pad and fasteners to trim casing.

2. Position trim casing, align fasteners with holes in door and press firmly into position.

3. Instal trim studs to casing.

4. Instal sill button guide.

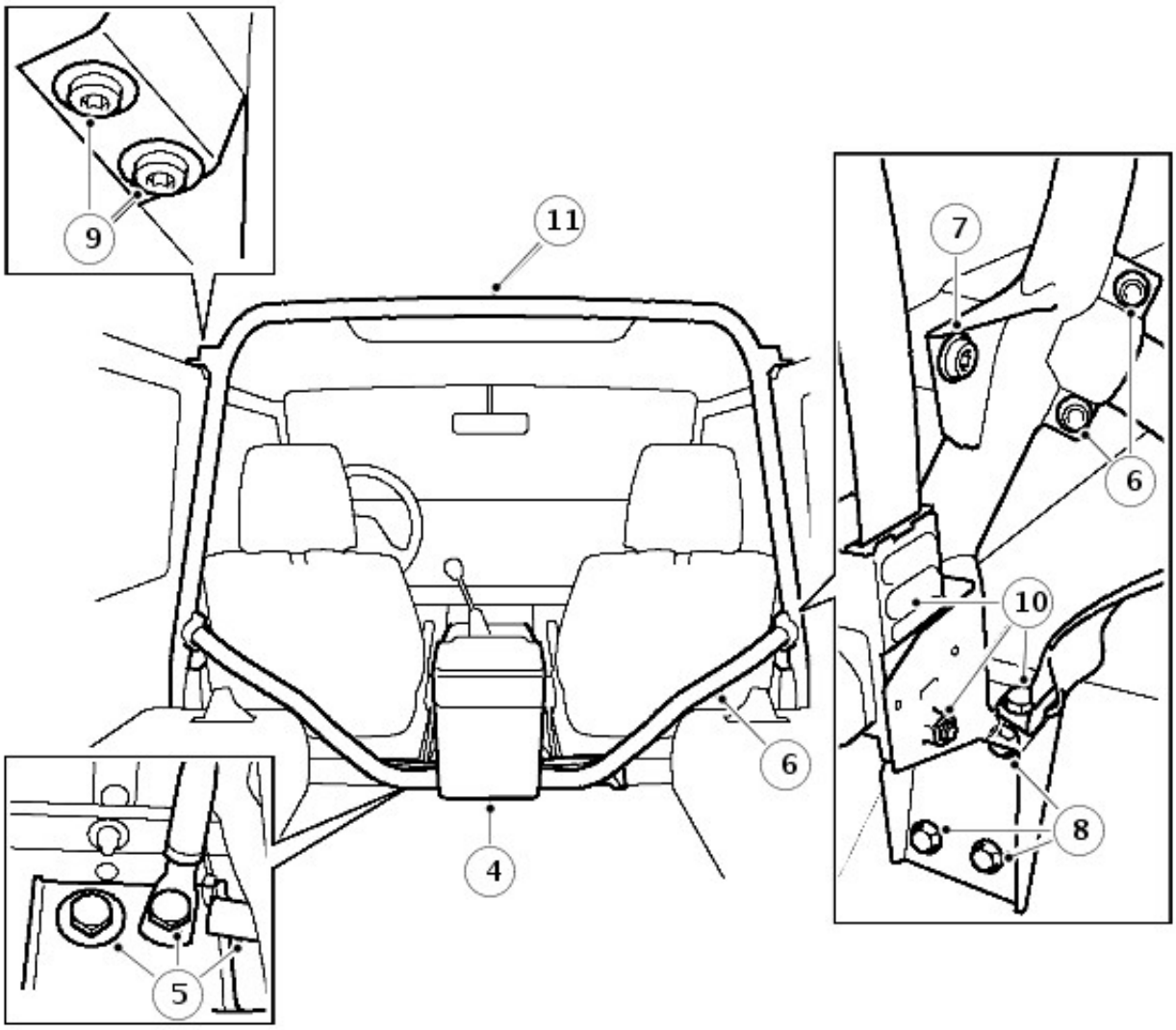
5. Instal escutcheon to door handle and secure with screw.

6. Instal door pull and secure with screws.

Interior Trim and Ornamentation - Interior Rollover Bar
Removal and Installation

Removal

1. Remove rear seat cushions.
   For additional information, refer to: Rear Outer Seat Cushion (501-10, Removal and Installation) / Rear Seat Cushion (501-10 Seating, Removal and Installation).
2. Remove cowl side trim panels.
   For additional information, refer to: Cowl Side Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Remove C-pillar upper trim panel.
   For additional information, refer to: C-Pillar Upper Trim Panel - 4.0L, 90 (501-05, Removal and Installation) / Cowl Side Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
4. Remove floor console extension.
   For additional information, refer to: Floor Console Extension (501-12, Removal and Installation).
5. Remove 4 bolts securing centre section of rollover bar and seat belt stalks to floor.
6. Remove 2 torx bolts and nuts from both sides and detach centre section of rollover bar assembly.
7. Remove torx bolt, from both sides, securing rollover bar to body side mounting brackets.
8. Remove 3 bolts and washers, from both sides, securing lower rollover bar brackets to front of wheelarch.
9. Remove 2 torx bolts and washers, from both sides, securing rollover bar upper mountings to roof fixing brackets and carefully lower complete assembly to floor.
10. Unscrew retaining bolts, from both sides, and remove front seat belt inertia reels and rear seat belts from rollover bar mounting.
11. Supporting from both sides, raise and tilt rollover bar rearwards to clear wheel arches.



76M2381

12. NOTE: Assistance may be required to remove rollover bar.

Remove rollover bar from vehicle.

Installation

1. Supporting from both sides, position rollover bar, engage struts in rear corners and front of side panels. Align on floor.
2. Secure front seat belt inertia reels and rear seat belts to rollover bar mountings. Tighten bolts to 32 Nm (24 lbf.ft).
3. Raise rollover bar assembly and secure to roof mounting brackets. Tighten bolts to 45 Nm (33 lbf.ft).
4. Secure rollover bar to wheel arches. Tighten bolts to 45 Nm (33 lbf.ft).
5. Secure rollover bar to body side mounting brackets, tightening bolts to 45 Nm (33 lbf.ft).
6. Secure centre section to main rollover bar, but do not fully tighten fixing bolts at this stage.
7. Secure seat belt stalks and rollover bar floor mounting brackets to chassis. Tighten bolts to 32 Nm (24 lbf ft.).

8. Fully tighten rollover bar centre section retaining bolts to 45 Nm (33 lbf.ft).

9. Fit floor console extension.
For additional information, refer to: Floor Console Extension (501-12, Removal and Installation).

10. Fit C-pillar upper trim panel.
For additional information, refer to: C-Pillar Upper Trim Panel - 4.0L, 90 (501-05, Removal and Installation) / Cowl Side Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

11. Fit cowl side trim panels.
For additional information, refer to: Cowl Side Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

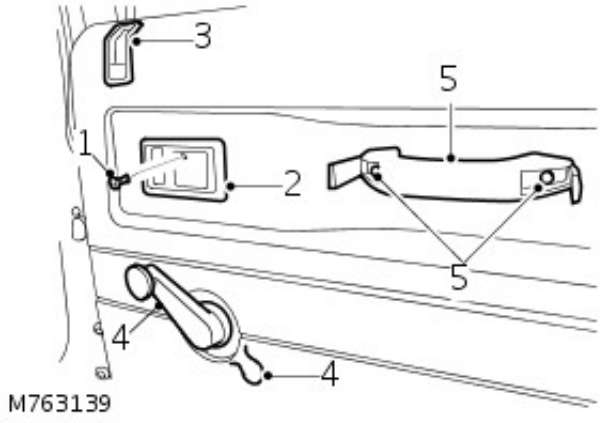
12. Fit rear seat cushions.
For additional information, refer to: Rear Outer Seat Cushion (501-10, Removal and Installation) / Rear Seat Cushion (501-10 Seating, Removal and Installation).

Interior Trim and Ornamentation - Rear Door Trim Panel

Removal and Installation

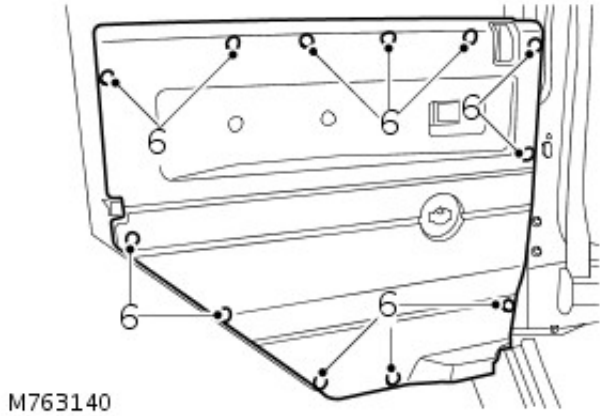
Removal

1. Remove screw securing door handle escutcheon.
2. Remove escutcheon.
3. Remove interior lock button bezel.
4. Remove retaining clip and remove door glass regulator handle.
5. Release covers and remove 2 screws securing door pull to door.



M763139

6. Carefully release 12 clips securing trim casing to door and remove door casing.



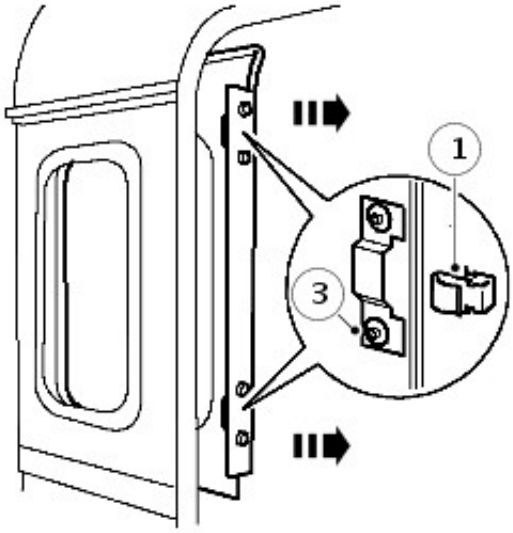
M763140

Installation

1. Instal trim casing to door and secure with clips.
2. Instal door glass regulator handle.
3. Instal escutcheon to door handle and tighten screw.
4. Instal door lock button bezel.
5. Instal door pull and secure with screws.

Interior Trim and Ornamentation - Rear Quarter Trim Panel

Removal and Installation



J6045

Removal

1. Pull edge of rear quarter trim panel firmly to release 2 spring retaining clips from vertical rail at door aperture.
2. Remove rear quarter trim panel.
3. Remove spring clips from the 2 brackets on side of trim panel.

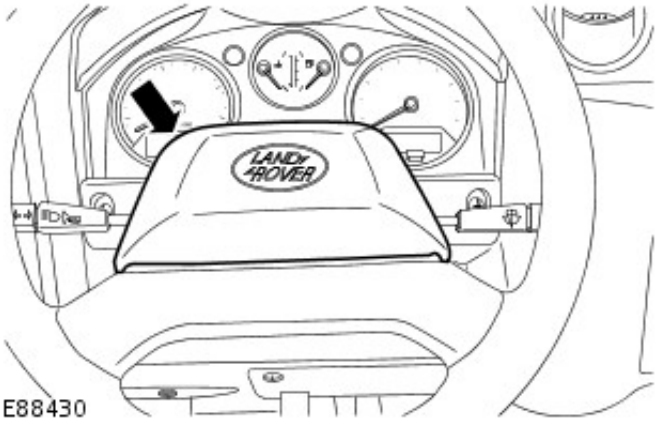
Installation

1. Instal new spring clips to the 2 brackets on side of trim panel.
2. Position outboard edge of trim panel in corner to abut quarter trim panel and locate spring clips on vertical rail.
3. Press edge of trim panel firmly to secure in position.

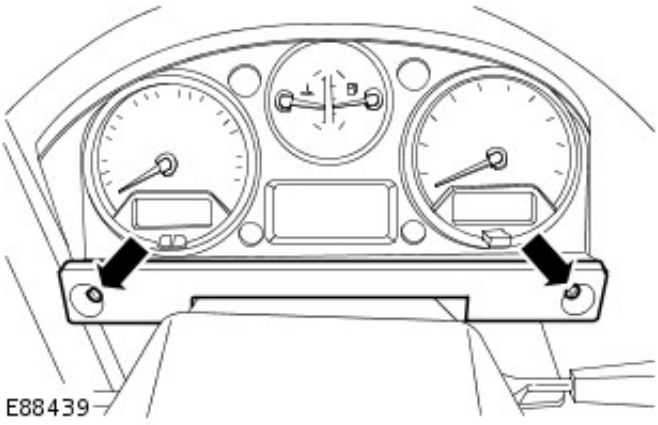
Interior Trim and Ornamentation - Steering Column Shrouds

Removal and Installation

Removal

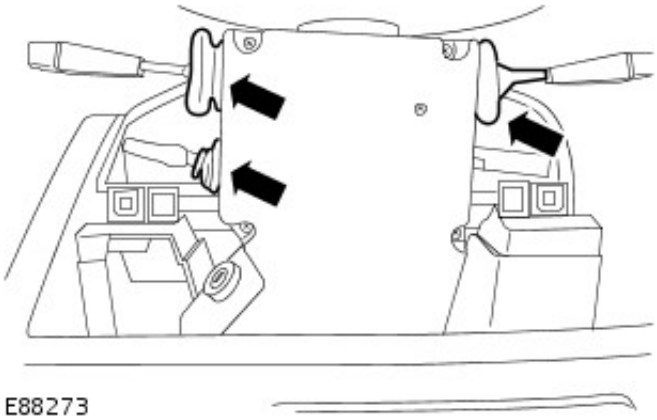


1. Remove the steering wheel center pad.



2. Remove the instrument cluster lower finisher.

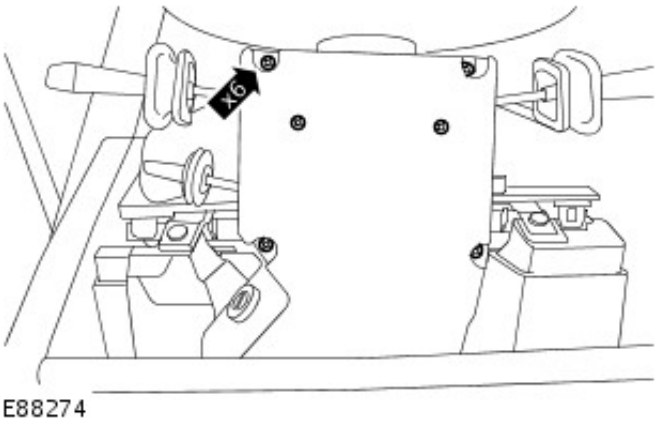
- Remove the 2 screws.



3. Release the 3 grommets from the steering column shrouds.

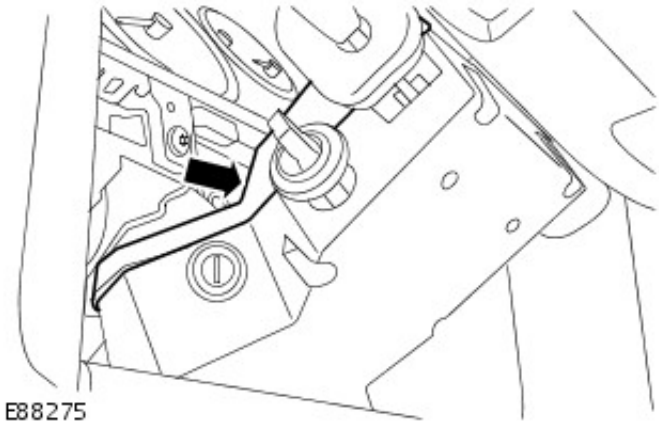
4. Remove the grommet.

5. Remove the 6 screws.

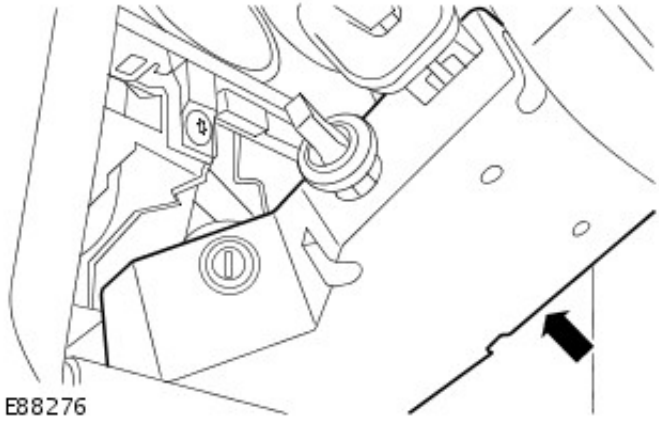


E88274

6. Remove the upper steering column shroud.


E88275

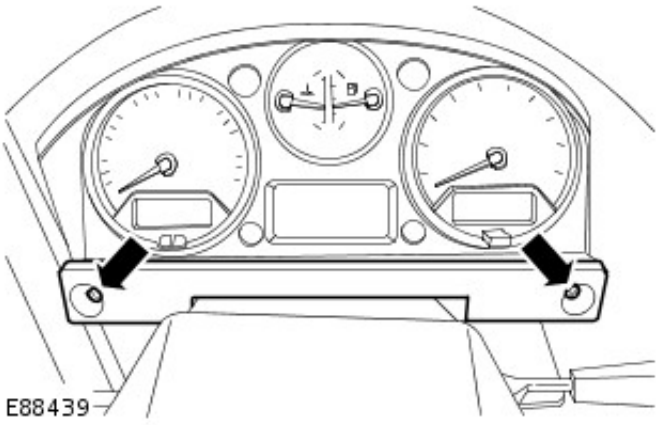
7. Remove the lower steering column shroud.


E88276

Installation

1. To install, reverse the removal procedure.

- Tighten to 2 Nm (1 lb.ft).

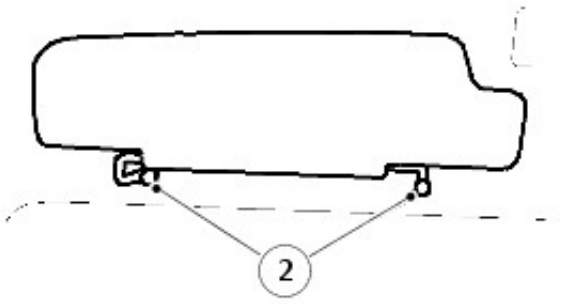

E88439

Interior Trim and Ornamentation - Sun Visor

Removal and Installation

Removal

1. Raise sun visor.



J6053

2. Remove 2 screws and collect sun visor.

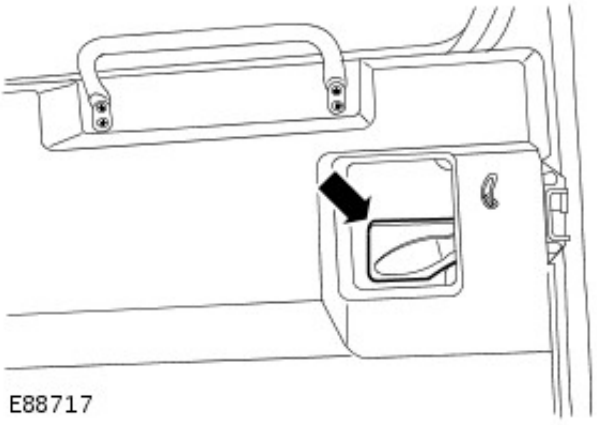
Installation

1. Position sun visor and secure with 2 screws.

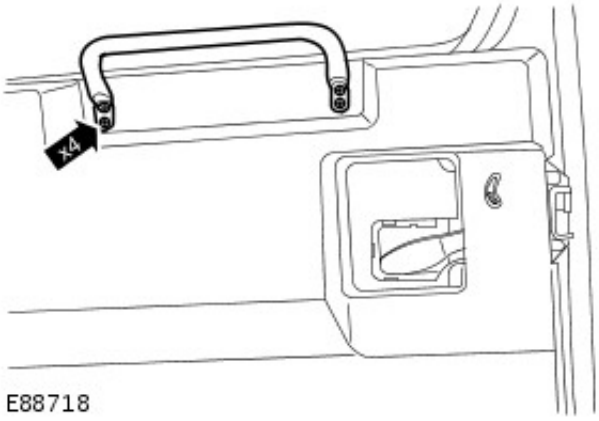
Interior Trim and Ornamentation - Taildoor Trim Panel

Removal and Installation

Removal



1. Remove the taildoor trim panel trim finisher.

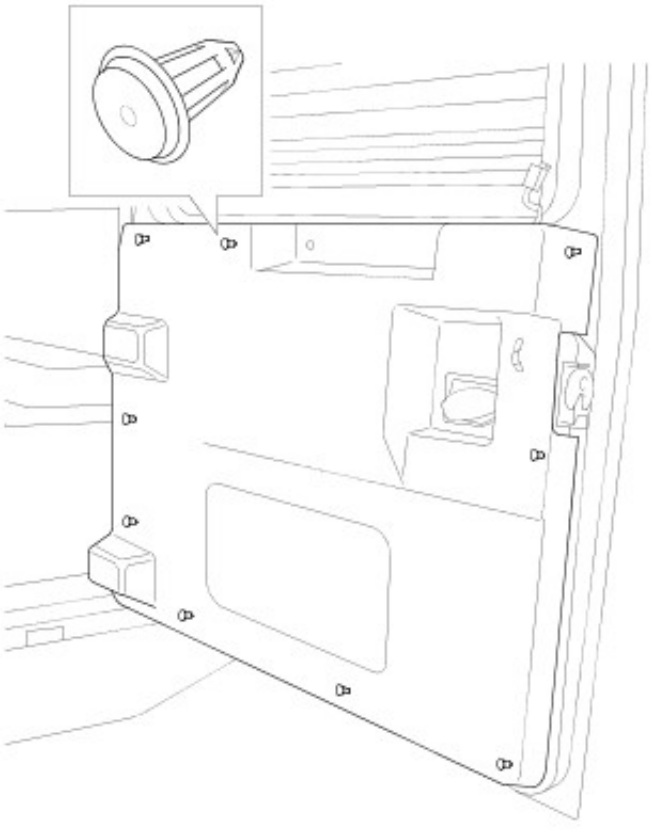


2. Remove the taildoor grab handle.

- Remove the 4 screws.

3. Remove the taildoor trim panel.

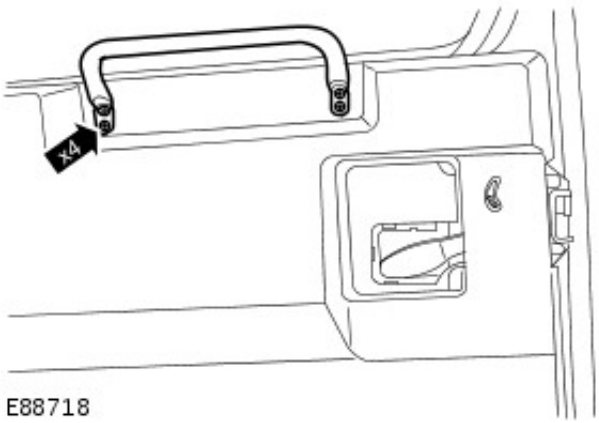
- Release the 9 clips.



4. NOTE: Do not carry out further dismantling if component is removed for access only.

Remove the 9 clips from the taildoor trim panel.

Installation



1. To install, reverse the removal procedure.

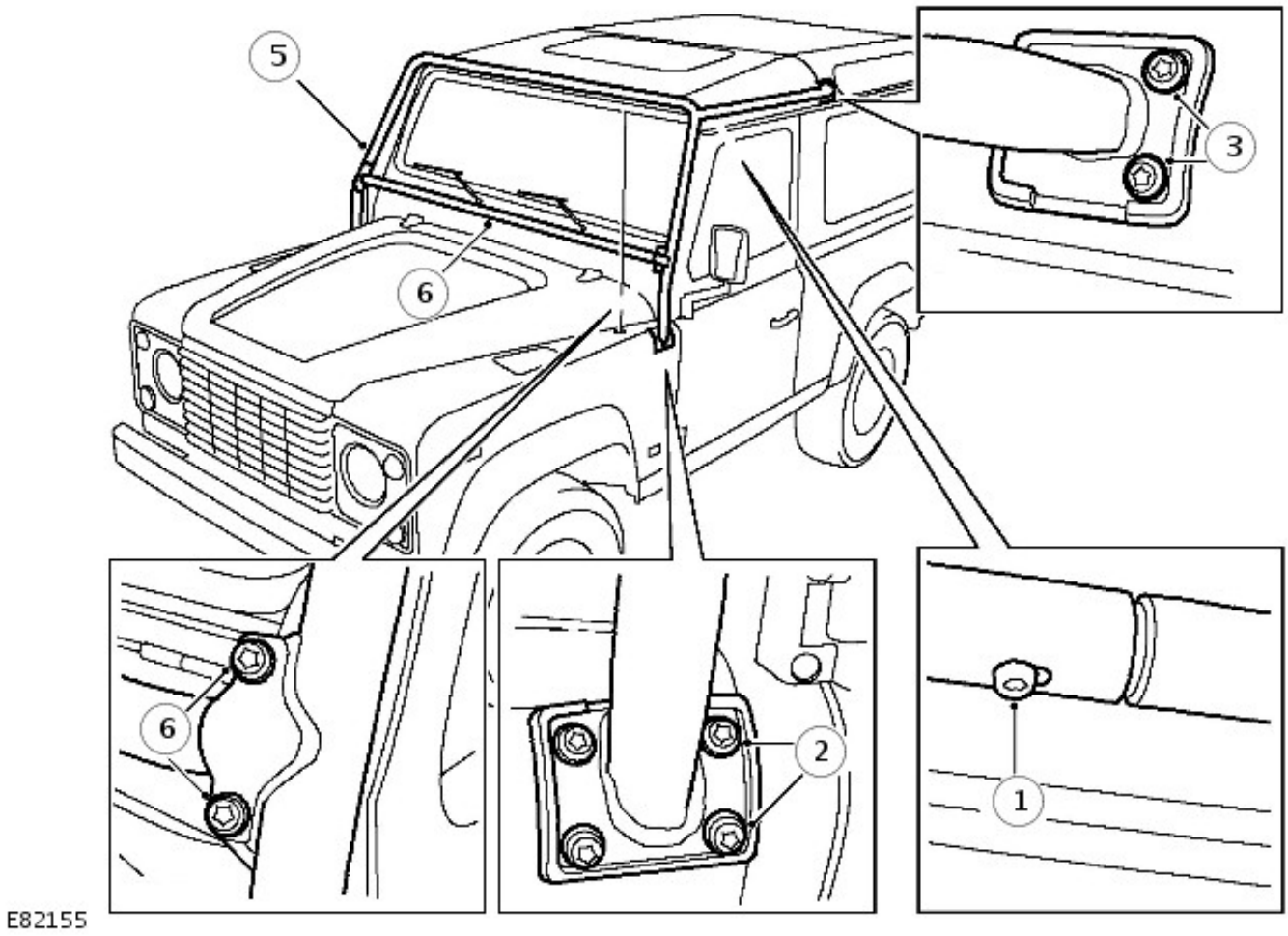
- Tighten to 6 Nm (4 lb.ft).

Exterior Trim and Ornamentation - Exterior Rollover Bar

Removal and Installation

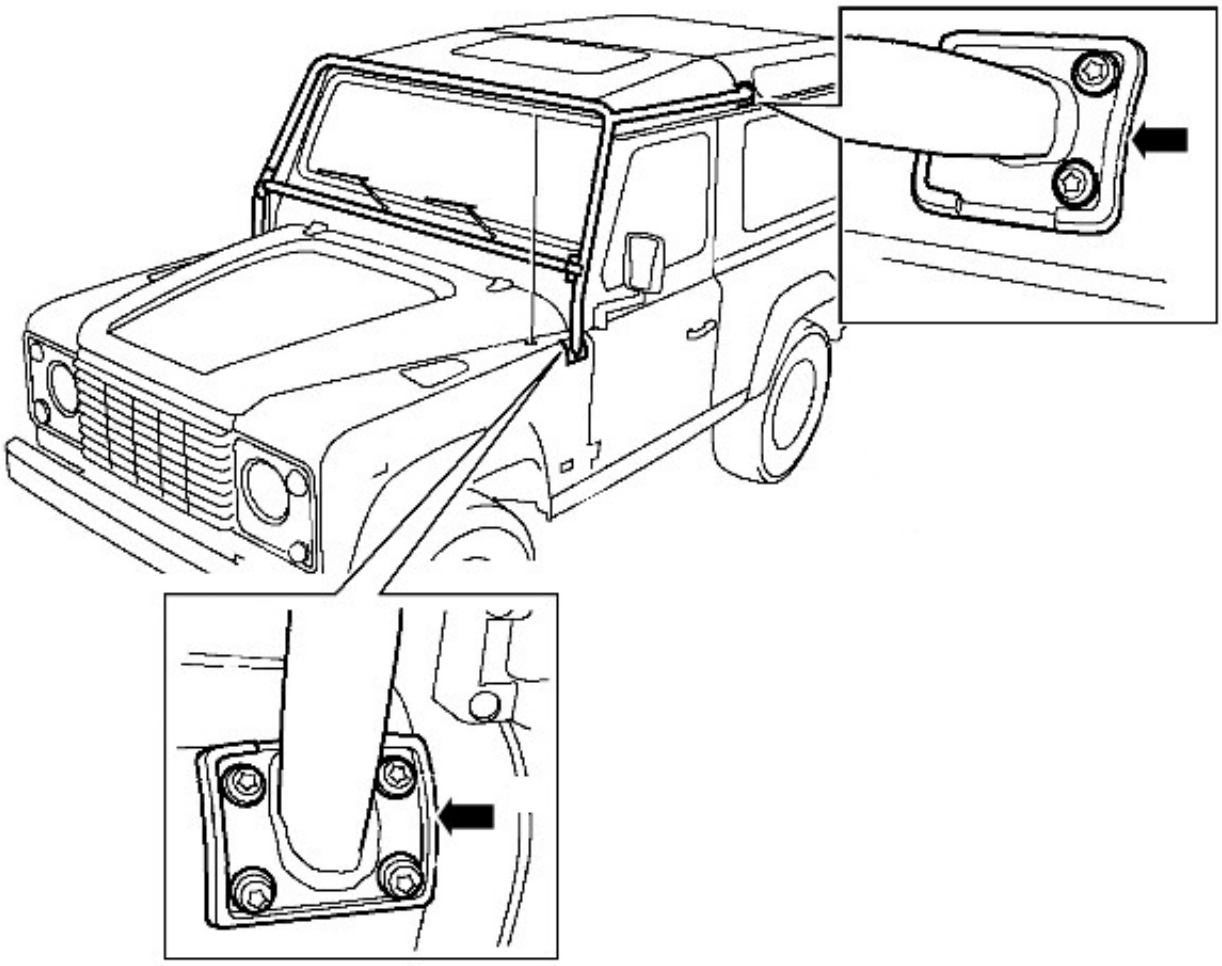
Removal

1. Remove Torx bolt, from both sides, securing top of rollover bar to roof mounted bar.
2. With assistance to support rollover bar at windshield, remove 4 Torx bolts, from both sides, securing rollover bar to fender mounting.
3. Remove two Torx bolts, from both sides, securing top bar to roof mounting.
4. Slide top bars rearwards to disengage from main rollover bar assembly.
5. Lift main rollover bar assembly from vehicle.
6. If necessary, remove 2 Torx bolts and nuts, from both sides, and detach lower cross bar from main rollover bar.



Installation

1. Locate lower cross bar into main rollover bar mounting brackets and secure with Torx bolts and nuts tightened to 25 Nm (18 lbf.ft).
2. Ensure rubber gaskets are fitted correctly to rollover bar mounting brackets.



E82105

3. With assistance, lift rollover bar assembly and position on fenders.

4. Slide top bars into main rollover bar, position on roof mounting and secure withTorx bolts to 25 Nm (18 lbf ft.).

5. Secure rollover bar to both fender mountings with Torx bolts. Tighten to 25 Nm (18 lbf.ft).

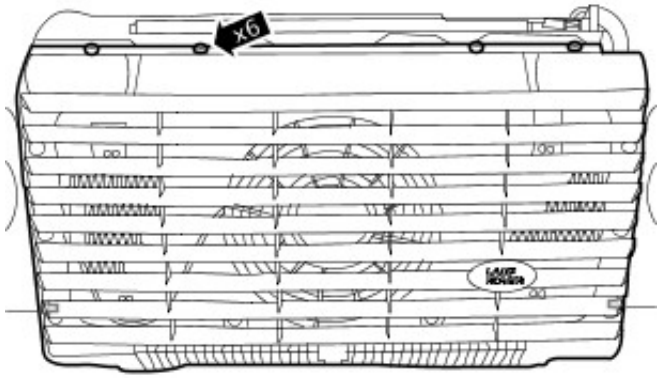
6. Secure top bars to main rollover bar and tighten fixing bolts to 25 Nm (18 lbf.ft).

Exterior Trim and Ornamentation - Radiator Grille

Removal and Installation

Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the radiator grille.
   - Remove the 6 screws.



E86147

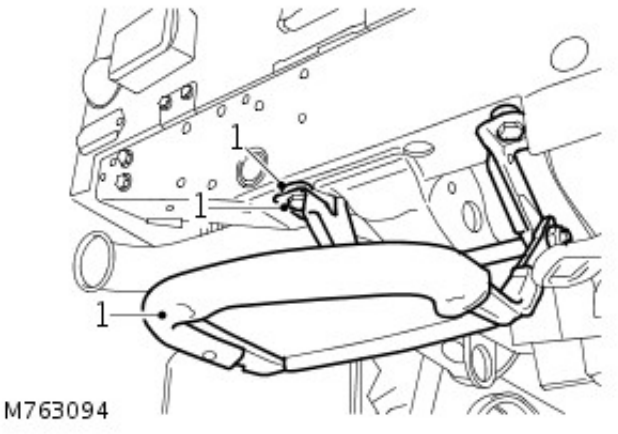
Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Exterior Trim and Ornamentation - Rear Folding Step

Removal and Installation

Removal



1. Remove 2 bolts securing step to chassis member, remove step and collect spacers.

Installation

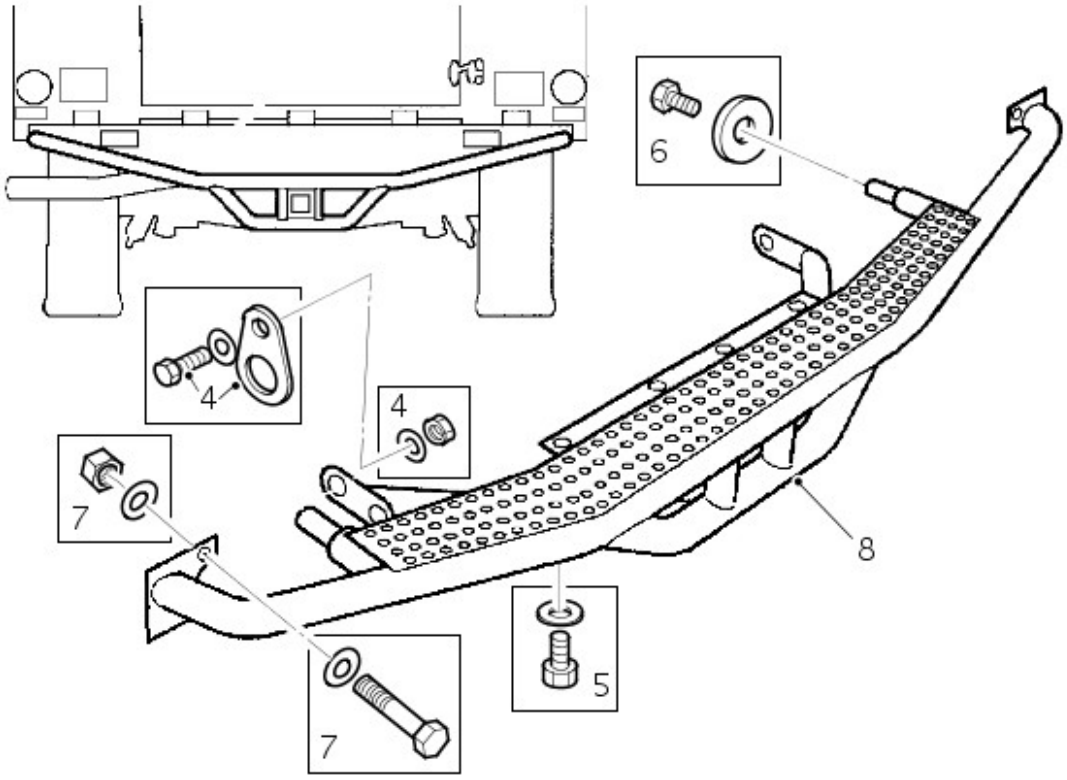
1. Position step, fit spacer washers and tighten bolts.

Exterior Trim and Ornamentation - Towbar

Removal and Installation

Removal

1. Remove 4 bolts securing stabilizer bar to rear undershield.
2. Remove 6 bolts securing rear undershield to chassis.
3. Remove rear undershield.
4. Remove bolt, washer and nut from both sides, securing tow bar lower mounting brackets and towing eyes to chassis.
5. Remove 4 bolts and spring washers securing tow bar centre mounting bracket to chassis.
6. Remove both bolts securing 2 tow bar locating tubes in chassis rear cross member.
7. Remove 2 bolts securing tow bar top mounting brackets to chassis.
8. With assistance, withdraw tow bar assembly from chassis.



E82156

Installation

1. With assistance, lift tow bar assembly and locate both tubes in chassis crossmember.
2. Secure top tow bar mounting brackets to chassis but do not fully tighten fixings.
3. Secure tow bar locating tubes to rear of chassis and tighten bolts to 25 Nm (18 lbf.ft).
4. Secure tow bar centre mounting bracket to underside of chassis and tighten bolts to 25 Nm (18 lbf.ft).
5. Position towing eyes to lower mounting brackets and secure to chassis and tighten bolts to 25 Nm (18 lbf.ft).
6. Fully tighten tow bar top mounting bracket bolts to 25 Nm (18 lbf.ft).
7. Fit rear undershield and secure to chassis with bolts.
8. Fit bolts securing rear stabilizer bar and tighten to 30 Nm (22 lbf.ft).

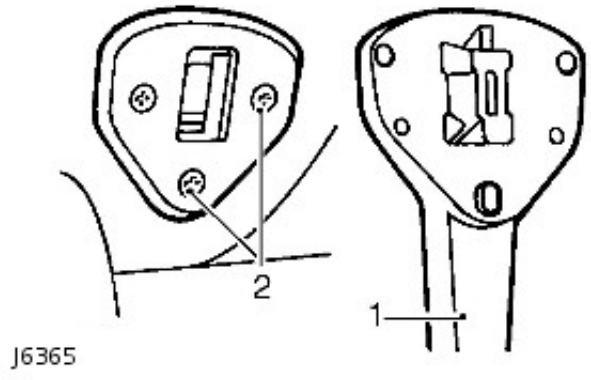
Rear View Mirrors - Interior Mirror

Removal and Installation

Removal

1. Prise interior mirror arm from mounting plate.

2. Remove 3 screws and remove mounting plate from headlining.



Installation

1. Install mounting plate to headlining.

2. Locate lower lug of mirror arm in mounting plate aperture.

3. Press mirror arm firmly to engage the spring clip.

Seating -

Torque Specifications

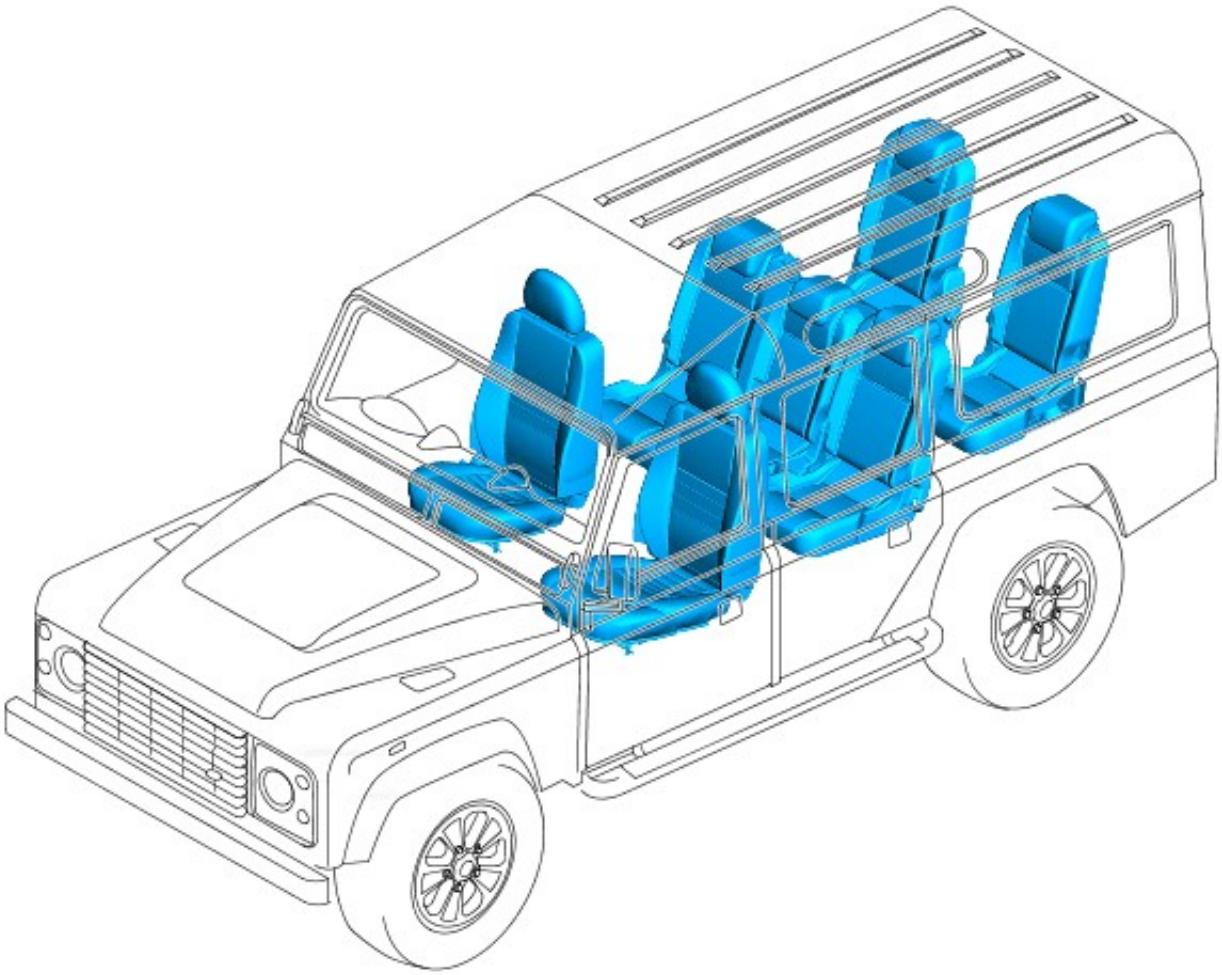
Description	Nm	lb-ft
Rear seat base stop bolt	23	17
Rear seat bolts	23	17
Rear seat nuts	23	17
+ Front seat backrest nuts and bolts	23	17
Front seat bolts	23	17
Third row seat bolts	23	17
Third row seat nuts	23	17
Third row seat nut and bolt	23	17

+ New nuts must be installed

Seating - Seats

Description and Operation

COMPONENT LOCATION



E83752

OVERVIEW

Vehicles from 2007 model year are fitted with an all new seating system. The front seats are manually adjustable for reach and recline. Some vehicles may also feature heated front seats. The heated front seats will only operate when the ignition is switched on.

The second row seats feature a 60/40 split and are able to be folded forward to increase the loadspace in the rear of the vehicle. Defender 110 Station Wagons are fitted with 2 forward facing third row seats. The third row seats can be stowed at the side of the cabin to increase the loadspace in the rear of the vehicle. For more information on seat stowage, refer to the Owners Handbook.

PRINCIPLES OF OPERATION

Heated Front Seats

When the ignition switch is in position II (ignition on) a feed is provided to the window lift relay coil via the central junction box (CJB). The ground path for the relay coil is controlled by the left-hand (LH) and right-hand (RH) heated seat switches. When either switch is pressed, the relay energizes and provides a battery voltage feed to the appropriate seat heater elements. Both seats contain 2 heating elements; 1 in the cushion, 1 in the backrest, which are wired in series.

The cushion elements in both front seats contain a thermostatically controlled switch. When the cushion element temperature reaches 37 ± 3°C (98 ± 3°F) the thermostat cuts the supply to both the cushion and backrest elements. When the temperature of the cushion element falls below 28 ± 3°C (82 ± 3°F) the thermostat reinstates the supply to both heater elements.

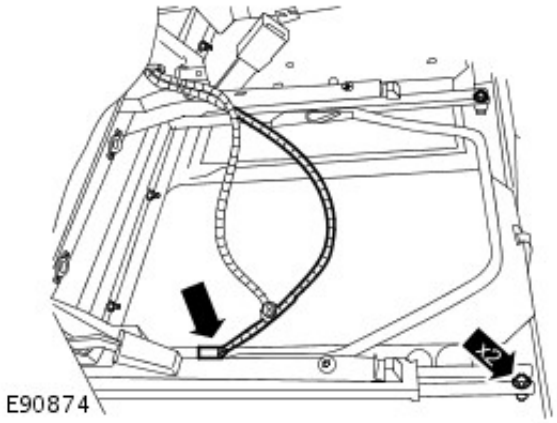
Seating - Front Seat
Removal and Installation

Removal

1. Remove the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

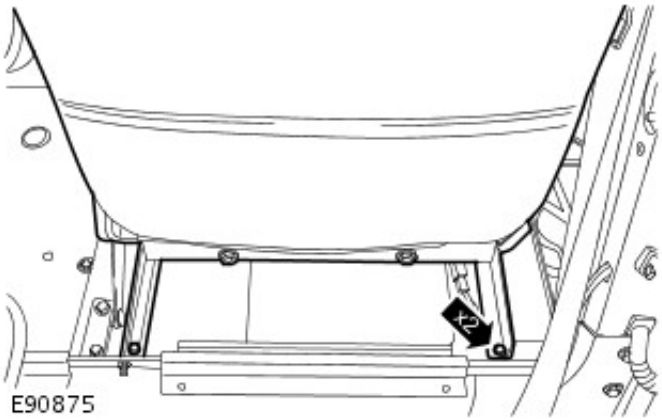
2. Remove the front 2 bolts from the front seat.

- Disconnect the front seat heater mat electrical connector.



3. Remove the front seat.

- Slide the front seat forwards.
- Remove the 2 bolts.
- Collect the 8 spacer washers.



Installation

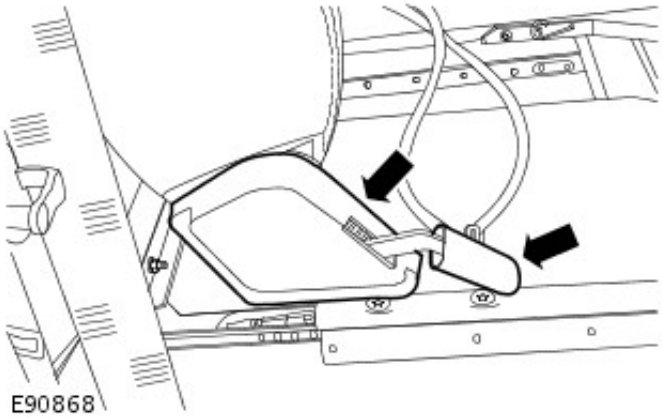
1. To install, reverse the removal procedure.

- Tighten the bolts to 23 Nm (17 lb.ft).

Seating - Front Seat Backrest
Removal and Installation

Removal

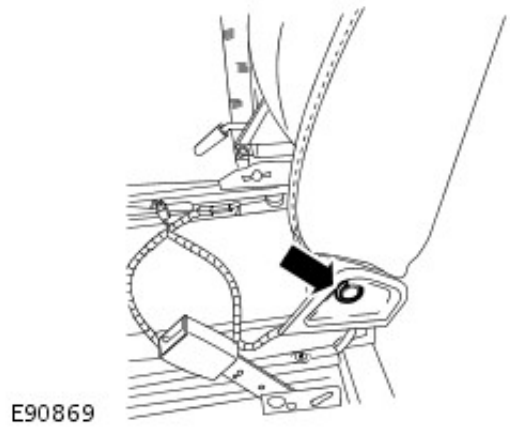
CAUTION: Do not attempt to adjust or dismantle the front seat tilt mechanism, the front seat backrest must be replaced as a complete assembly, failure to follow this instruction may result in damage to the vehicle.



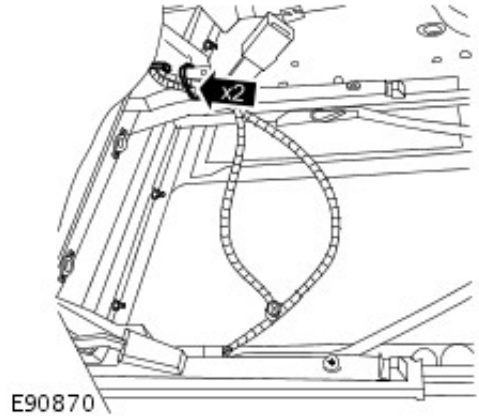
1. Remove the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

2. Remove the front seat backrest hinge cover.

- Remove the front seat recliner handle.



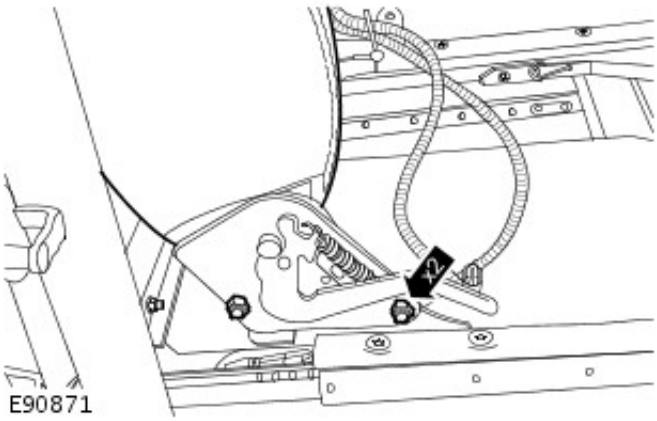
3. Remove the front seat backrest hinge clip.



4. Release the front seat heater mat wiring harness.

- Remove and discard the 2 cable ties.

5. NOTE: Discard the nuts.



Remove the front seat backrest.

- Remove the 2 nuts and bolts.

Installation

1. NOTE: New nuts must be installed.

   Install the front seat backrest.

   - Tighten the nuts and bolts to 23 Nm (17 lb.ft).

2. Secure the front seat heater mat wiring harness.

   - Install new cable ties.

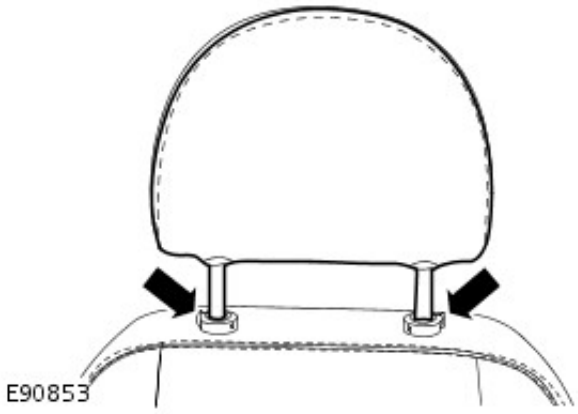
3. Install the front seat backrest hinge clip.
4. Install the front seat backrest hinge cover.

   - Install the front seat recliner handle.

Seating - Front Seat Backrest Cover

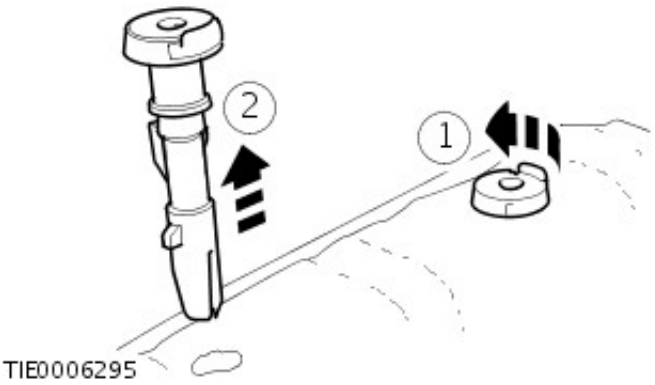
Removal and Installation

Removal



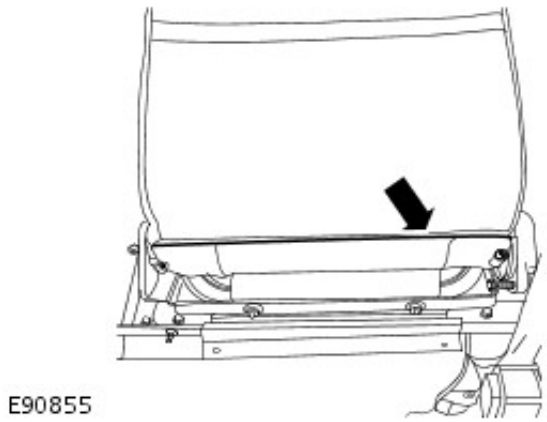
1. Remove the front seat head restraint.

- Release the 2 clips.



2. Remove the front seat head restraint guides.

- Turn the front seat head restraint guides 90 degrees counter clockwise.

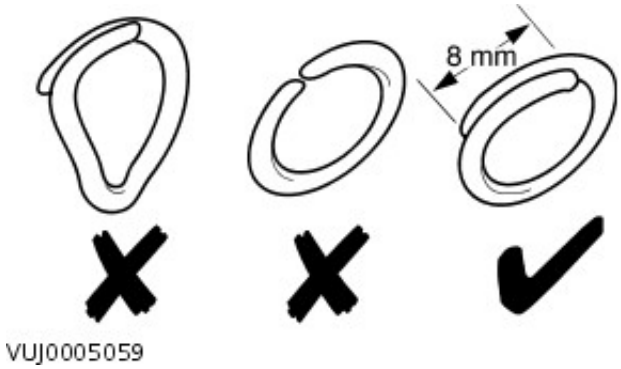


3. Release the front seat cover lower closing strip.

4. Remove the front seat backrest cover.

- Remove and discard the 11 hog rings.

Installation



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1. CAUTION: Care must be taken when installing the hog rings, failure to follow this instruction may result in damage to the vehicle.

• NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To install, reverse the removal procedure.

Seating - Front Seat Backrest Heater Mat

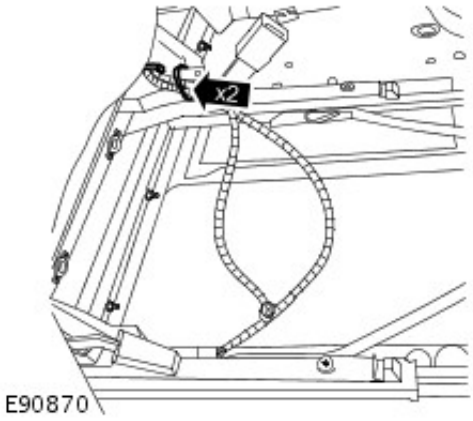
Removal and Installation

Removal

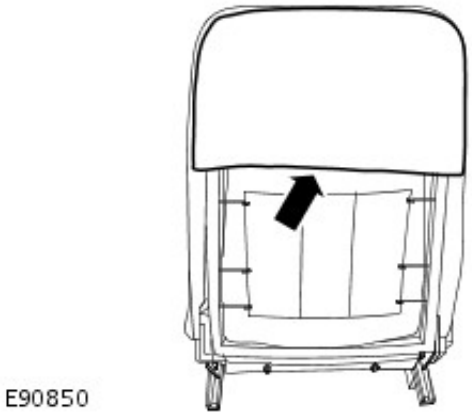
1. Remove the front seat backrest cover.
For additional information, refer to: Front Seat Backrest Cover (501-10 Seating, Removal and Installation).

2. Release the front seat heater mat wiring harness.

- Remove and discard the 2 cable ties.



3. Remove and discard the front seat backrest foam backing.

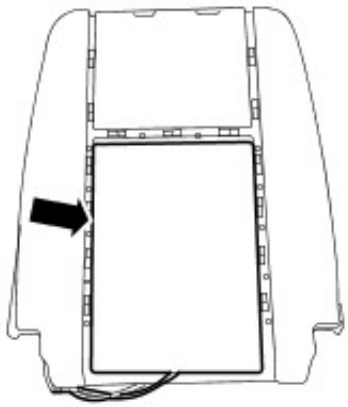


4. Remove and discard the front seat backrest cushion.

Installation

1. Install the front seat backrest heater mat to the front seat

backrest cushion.



E90852

2. NOTE: Clean the component mating faces.

Install the front seat backrest cushion.

- Secure the front seat backrest cushion using a suitable adhesive.

3. Install the front seat backrest foam backing.

4. Secure the front seat heater mat wiring harness.

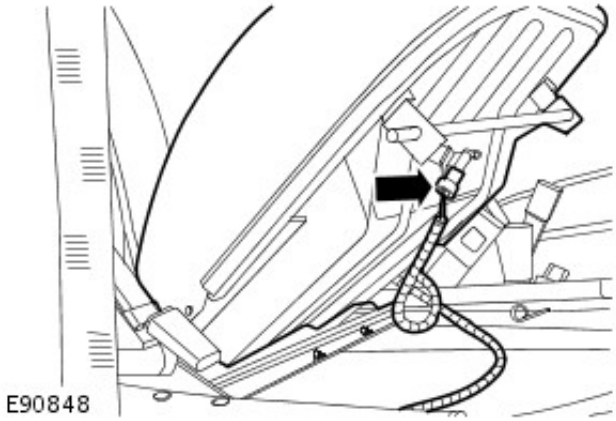
- Install new cable ties.

5. Install the front seat backrest cover.
For additional information, refer to: Front Seat Backrest Cover (501-10 Seating, Removal and Installation).

Seating - Front Seat Cushion

Removal and Installation

Removal



1. Remove the front seat cushion.

- Lift the front edge of the front seat cushion.
- Disconnect the front seat cushion heater mat electrical connector.

Installation

1. To install, reverse the removal procedure.

Seating - Front Seat Cushion Cover

Removal and Installation

Removal

1. NOTE: The front seat cushion cover is part of the front seat cushion and cannot be serviced separately.

Remove the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

Installation

1. Install the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

Seating - Front Seat Cushion Heater Mat

Removal and Installation

Removal

1. NOTE: The front seat cushion heater mat is part of the front seat cushion and cannot be serviced separately.

Remove the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

Installation

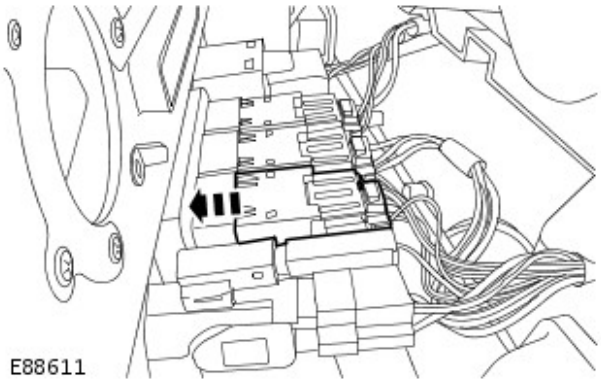
1. Install the front seat cushion.
For additional information, refer to: Front Seat Cushion (501-10 Seating, Removal and Installation).

Seating - Heated Seat Switch
Removal and Installation

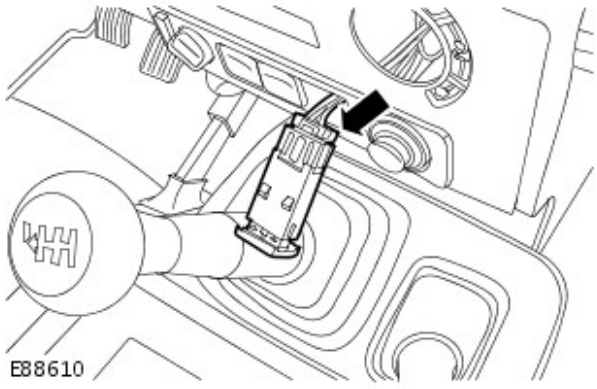
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. Release the instrument panel console.

4. Release the heated seat switch.



5. Remove the heated seat switch.
   - Disconnect the electrical connector.

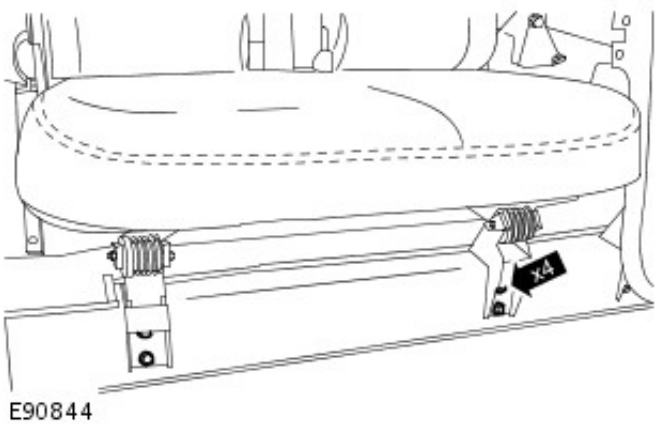


Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

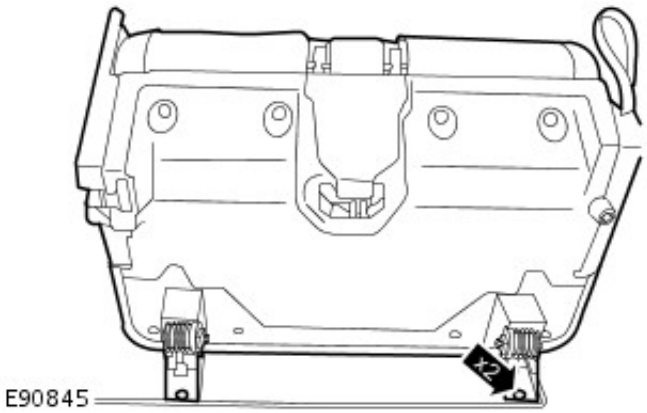
Seating - Rear Seat
Removal and Installation

Removal



1. Release the front edge of the rear seat.

- Remove the upper 2 bolts.
- Loosen the lower 2 bolts.



2. Remove the rear seat.

- Tilt the rear seat forwards.
- Remove the 2 nuts.

Installation

1. Install the rear seat.

- Tighten the nuts to 23 Nm (17 lb.ft).
- Lock the rear seat back in to position.

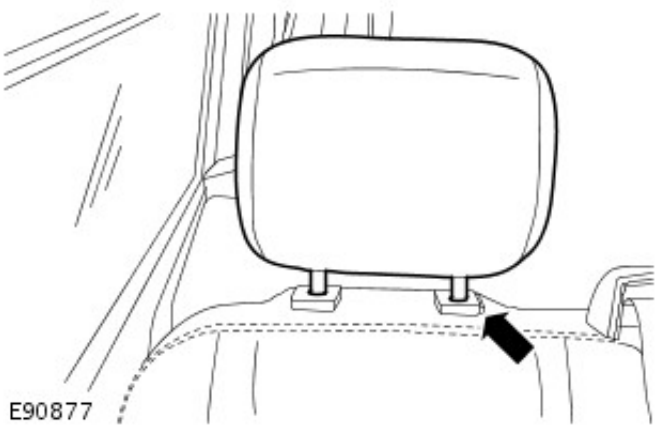
2. Secure the front edge of the rear seat.

- Tighten the bolts to 23 Nm (17 lb.ft).

Seating - Rear Seat Backrest

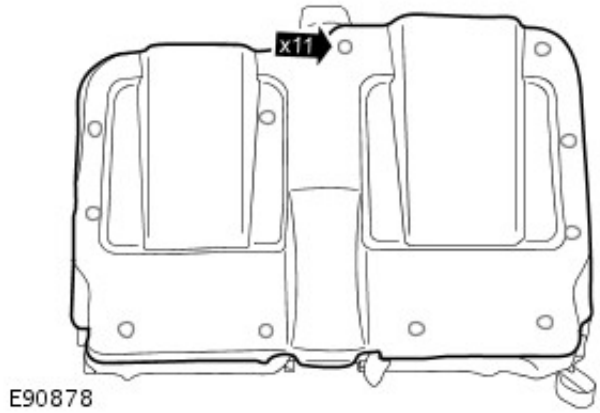
Removal and Installation

Removal



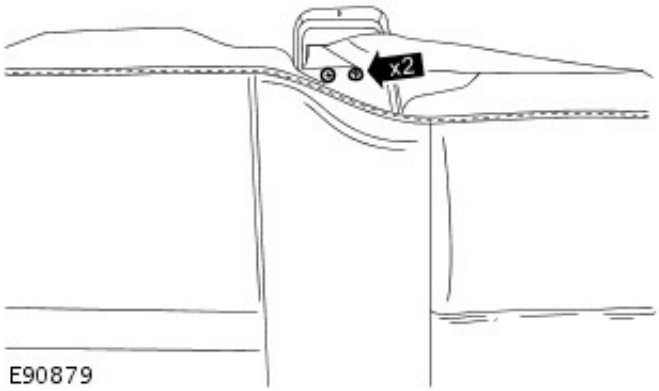
1. Remove the 2 rear seat head restraints.

- Release the 2 clips.



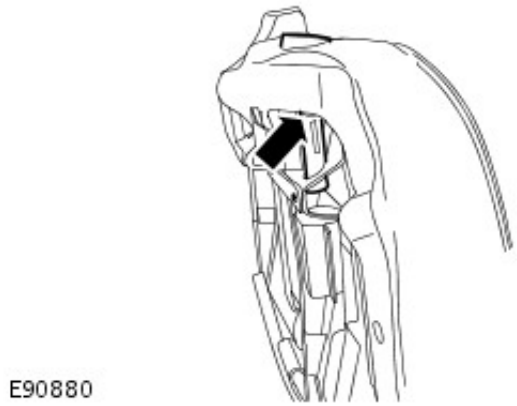
2. Remove the rear seat backrest trim panel.

- Release the 11 clips.



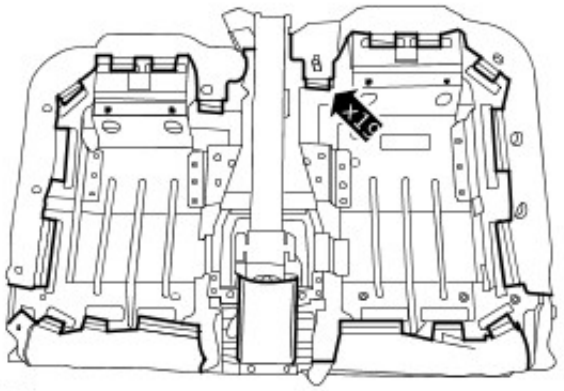
3. Reposition the rear center safety belt guide cover.

- Remove the 2 screws.



4. Remove the 4 rear seat head restraint guides.

- Release the 4 clips.



E90881

5. Remove the rear seat backrest.

- Release the 19 clips.

Installation

1. Install the rear seat backrest.

- Secure the 19 clips.

2. Install the rear seat head restraint guides.

3. Secure the rear center safety belt guide cover.

- Tighten the screws.

4. Secure the rear seat backrest trim panel.

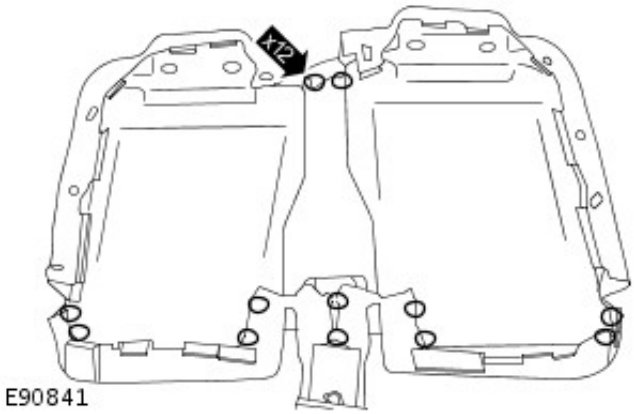
- Secure with the clips.

5. Install the rear seat head restraints.

Seating - Rear Seat Backrest Cover

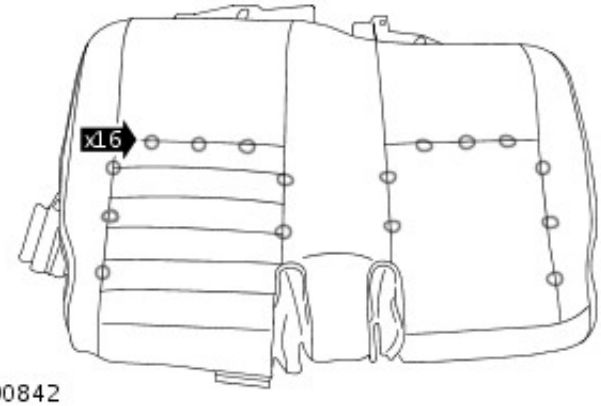
Removal and Installation

Removal



E90841

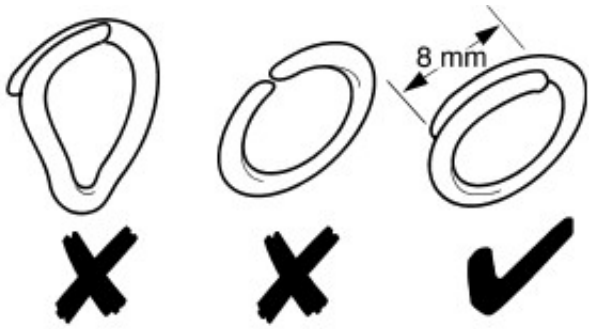
1. Remove the rear seat backrest.
   For additional information, refer to: Rear Seat Backrest (501-10 Seating, Removal and Installation).
2. Release the rear seat backrest cover.
   - Remove and discard the 12 hog rings.



E90842

3. Remove the rear seat back rest cover.
   - Remove and discard the 20 hog rings.

Installation



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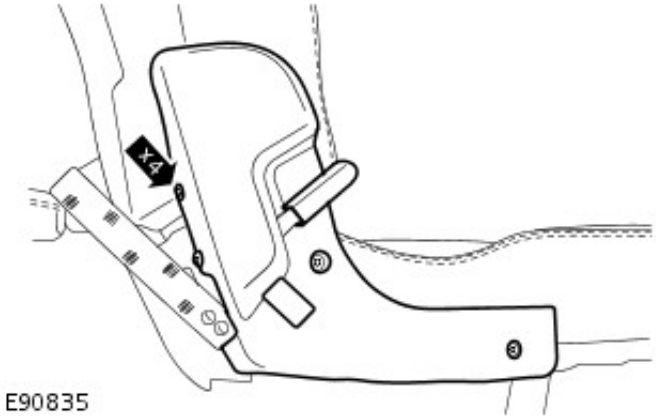
1. NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To install, reverse the removal procedure.

Seating - Rear Seat Cushion

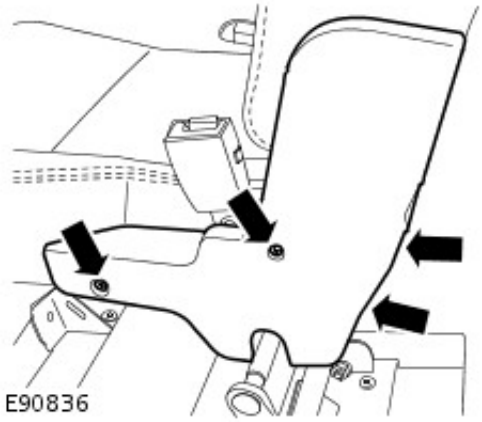
Removal and Installation

Removal



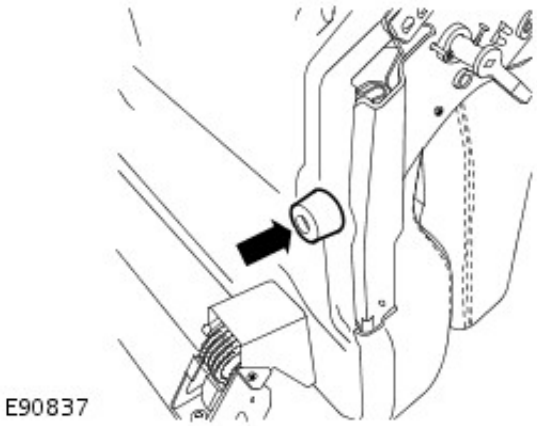
1. Remove the rear seat outer hinge trim panel.

- Remove the rear seat recliner handle.
- Remove the 4 screws.



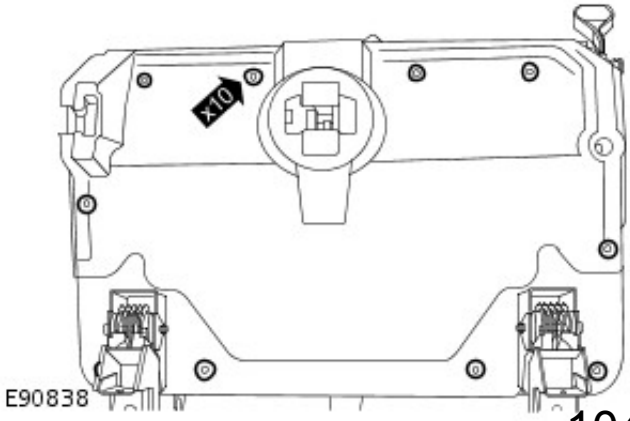
2. Remove the rear seat inner hinge trim panel.

- Remove the 4 screws.



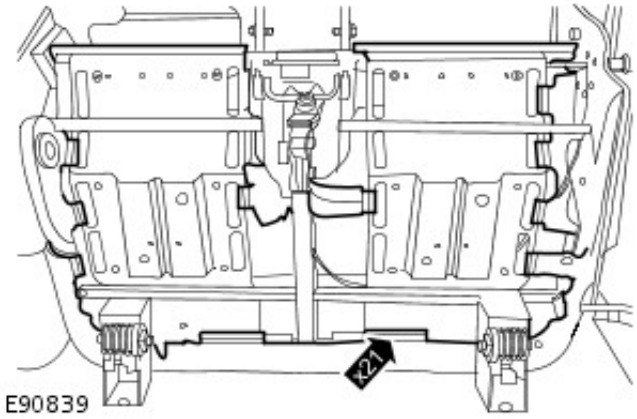
3. Remove the rear seat base stop.

- Remove the bolt.
- Collect the plastic washer.



4. Remove the rear seat cushion trim panel.

- Remove the 10 clips.



5. Remove the rear seat cushion.

- Release the 21 clips.

Installation

1. Install the rear seat cushion.

- Secure the clips.

2. Install the rear seat cushion trim panel.

- Install the clips.

3. Install the rear seat base stop.

- Install the plastic washer.
- Tighten the bolt to 25 Nm (17 lb.ft).

4. Install the rear seat inner hinge trim panel.

- Tighten the screws.

5. Install the rear seat outer hinge trim panel.

- Tighten the screws.
- Install the rear seat recliner handle.

Seating - Rear Seat Cushion Cover

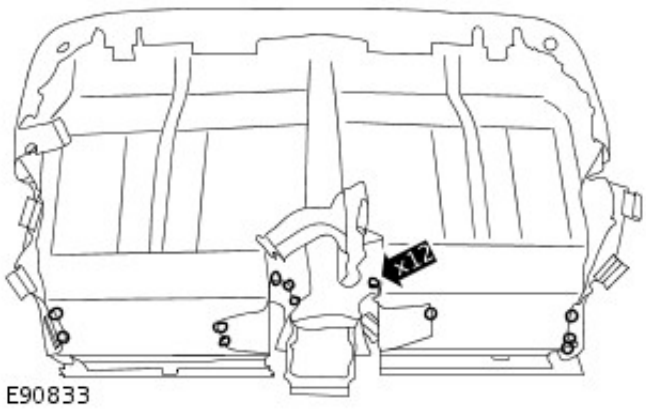
Removal and Installation

Removal

1. Remove the rear seat cushion.
For additional information, refer to: Rear Seat Cushion (501-10 Seating, Removal and Installation).

2. Release the under side of the rear seat cushion cover.

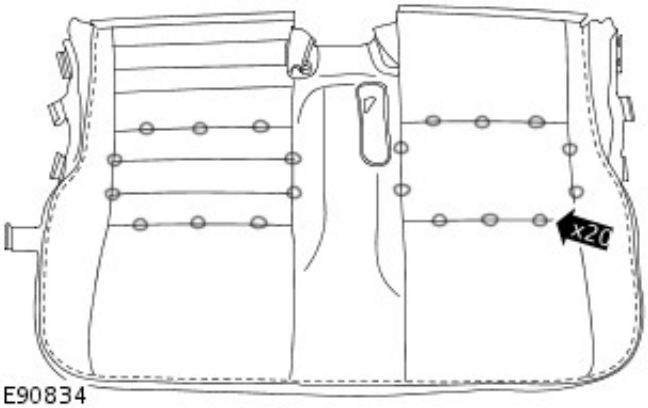
- Remove and discard the 12 hog rings.



E90833

3. Remove the rear seat cushion cover.

- Remove and discard the 20 hog rings.

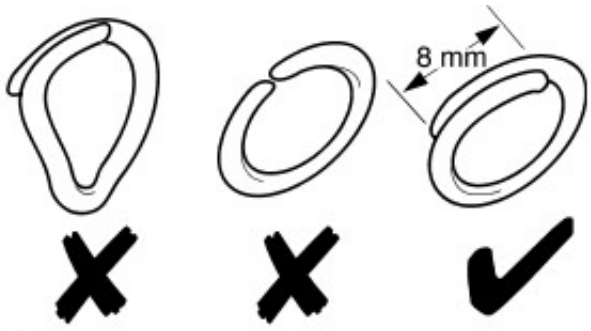


E90834

Installation

1. NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To install, reverse the removal procedure.



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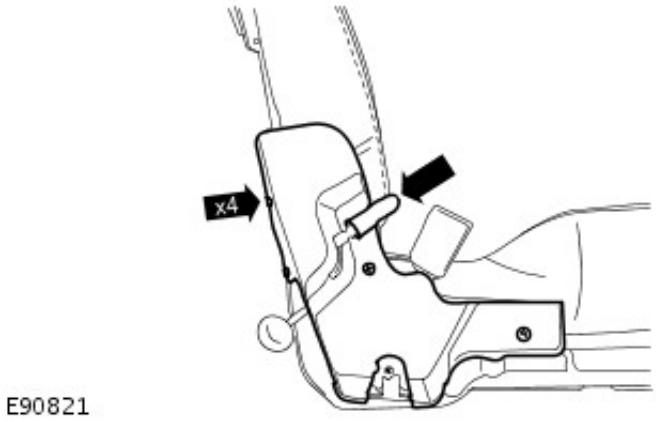
Seating - Third Row Seat

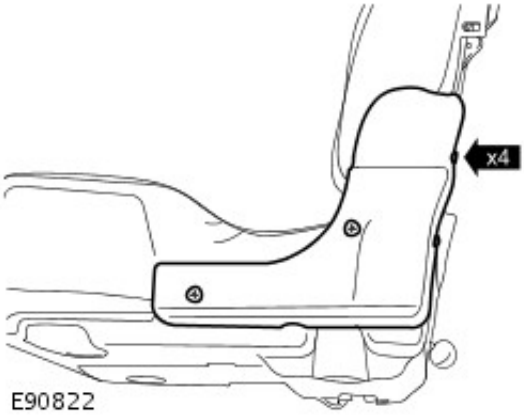
Removal and Installation

Removal



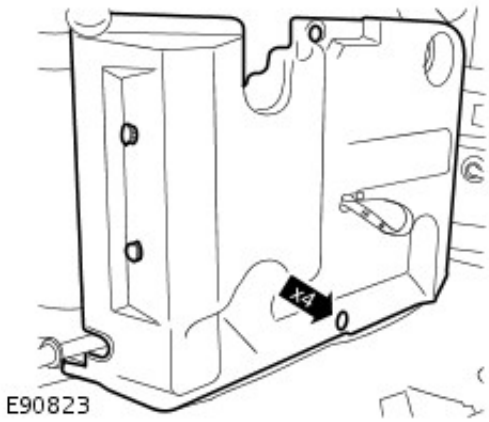
1. Remove the third row seat inner hinge trim panel.

- Remove the third row seat recliner handle.
- Remove the 4 screws.



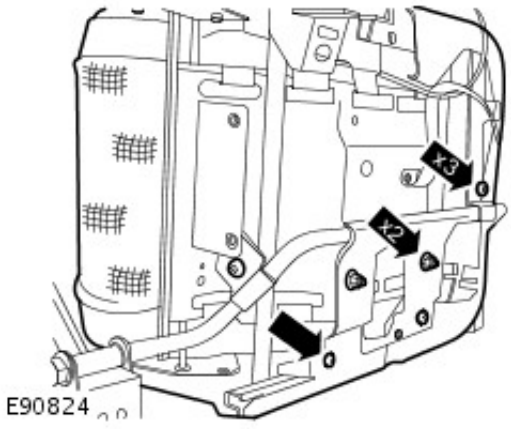
2. Remove the third row seat outer hinge trim panel.

- Remove the 4 screws.



3. Remove the third row seat lower trim panel.

- Remove the 4 clips.



4. Remove the third row seat.

- Remove the nut and bolt.
- Remove the 2 nuts.
- Remove the 3 bolts.
- Collect the 2 plastic washers.

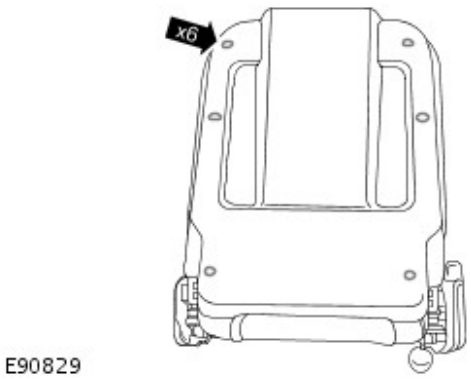
Installation

1. Install the third row seat.
   - Install the plastic washers.
   - Tighten the nuts to 23 Nm (17 lb.ft).
   - Tighten the bolts to 23 Nm (17 lb.ft).
   - Tighten the nut and bolt to 23 Nm (17 lb.ft).
2. Install the third row seat lower trim panel.
   - Install the clips.
3. Install the third row seat outer hinge trim panel.
   - Tighten the screws.
4. Install the third row seat inner hinge trim panel.
   - Tighten the screws.
   - Install the third row seat recliner handle.

Seating - Third Row Seat Backrest

Removal and Installation

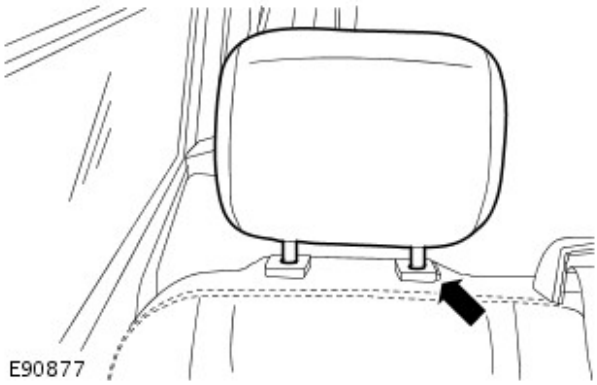
Removal



E90829

1. Remove the third row seat backrest trim panel.

- Release the 6 clips.



E90877

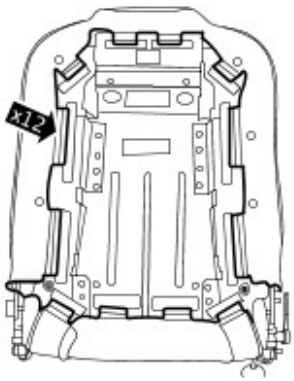
2. Remove the third row seat head restraint.

- Release the clip.

E90880

3. Remove the 2 third row seat head restraint guides.

- Release the 2 clips.



E90830

4. Remove the third row seat backrest.

- Release the 12 clips.

Installation

1. To install, reverse the removal procedure.

Seating - Third Row Seat Backrest Cover

Removal and Installation

Removal

1. Remove the third row seat backrest.
For additional information, refer to: Third Row Seat Backrest (501-10 Seating, Removal and Installation).

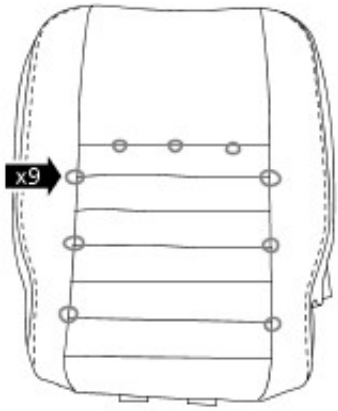
2. Release the third row seat backrest cover.

- Remove and discard the 4 hog rings.

E90831

3. Remove the third row seat backrest cover.

- Remove and discard the 9 hog rings.

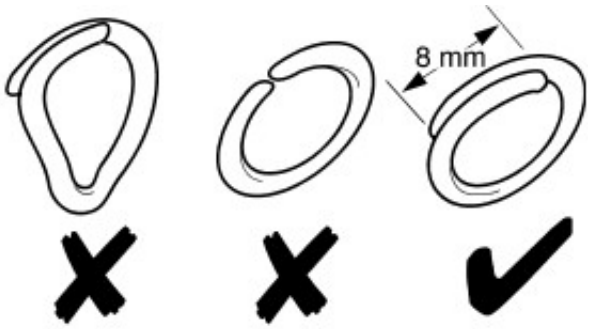


E90832

Installation

1. NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

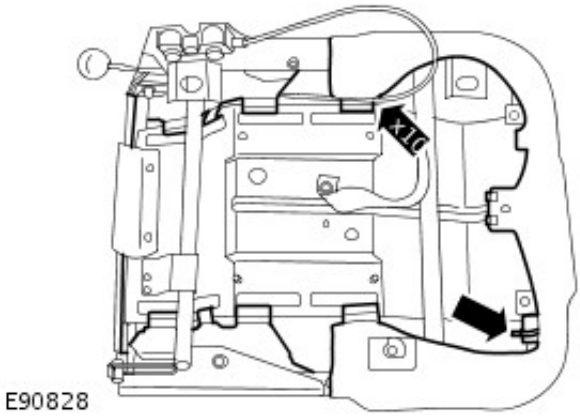
To install, reverse the removal procedure.



VUJ0005059

Seating - Third Row Seat Cushion

Removal and Installation



Removal

1. Remove the third row seat.
   For additional information, refer to: Third Row Seat (501-10 Seating, Removal and Installation).
2. Remove the third row seat cushion.
   - Remove and discard the cable tie.
   - Release the 10 clips.

Installation

1. To install, reverse the removal procedure.

Seating - Third Row Seat Cushion Cover

Removal and Installation

Removal

1. Remove the third row seat cushion.
For additional information, refer to: Third Row Seat Cushion (501-10 Seating, Removal and Installation).

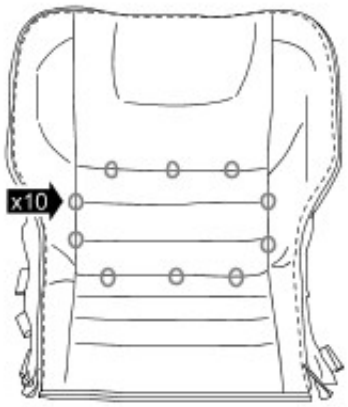
2. Release the third row seat cushion cover.

- Remove and discard the 4 hog rings.

E90825

3. Remove the third row seat cushion cover.

- Remove and discard the 10 hog rings.

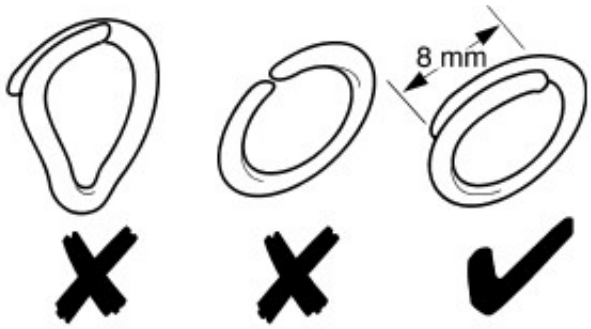


E90826

Installation

1. NOTE: Use hog ring pliers to close the hog rings. Do not use any other tool. The hog rings must be closed to overlap as illustrated.

To install, reverse the removal procedure.



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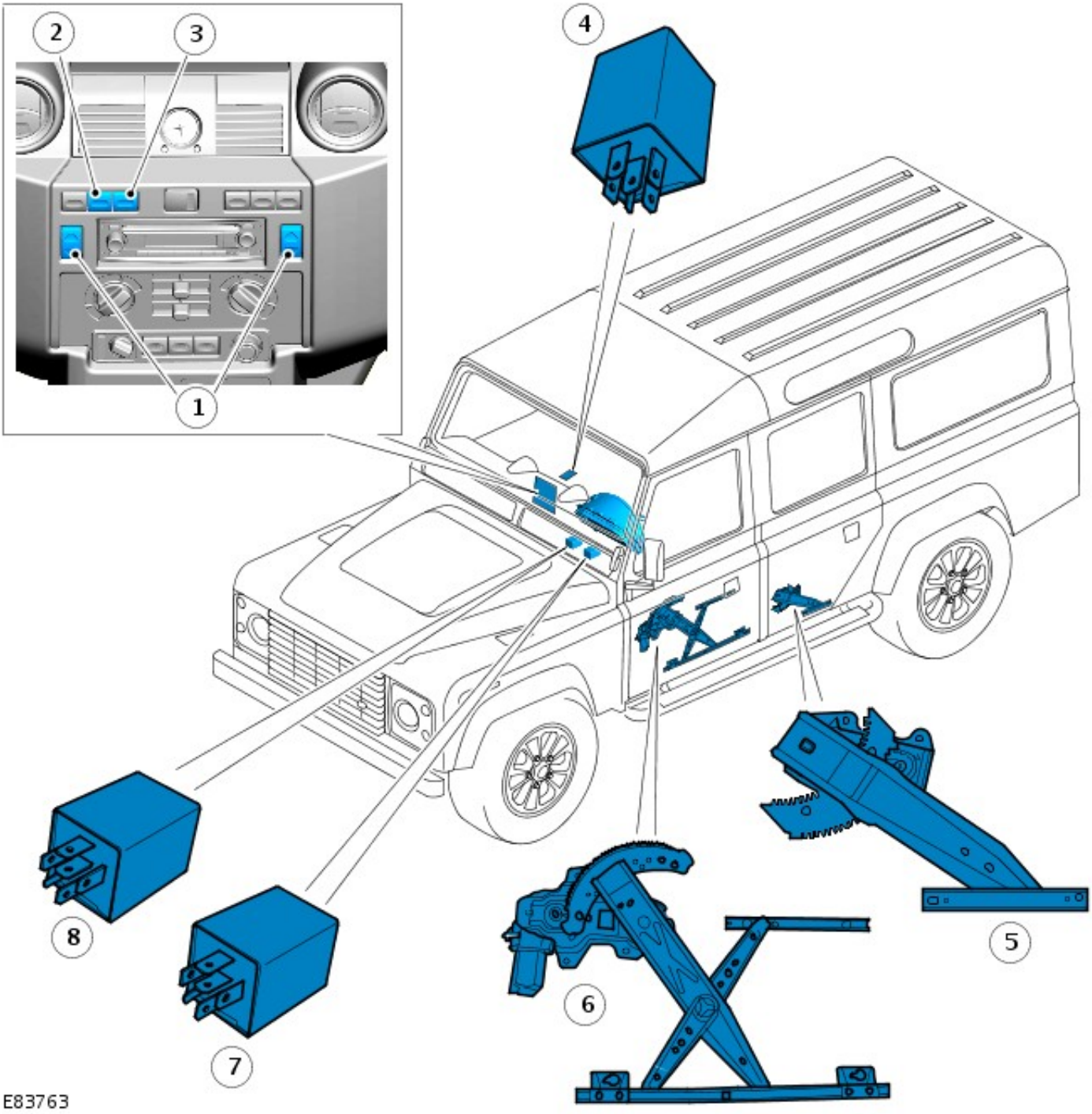
Glass, Frames and Mechanisms - Glass, Frames and Mechanisms

Description and Operation

COMPONENT LOCATION



Item	Part Number	Description
1	-	Window lift switches
2	-	Heated windshield switch
3	-	Heated rear window switch
4	-	Heated windshield module
5	-	Rear door window regulator (if fitted)
6	-	Front door window regulator and motor assembly
7	-	Heated rear window relay
8	-	Window lift relay

OVERVIEW

Window Lift

The front window lift system comprises a motor in each front door and 2 rocker switches mounted in the center console.

The window lift system will only operate when the ignition switch is in position II (ignition on) and features anti-trap functionality.

The rear window lift system (if fitted) comprises a handle and manually operated door window regulator in each rear door.

Heated Windshield and Rear Window

The heated windshield contains a single heating element which is powered for up to a maximum of 8 minutes when selected. The system is only operational when the engine is running.

The heated rear window also contains a single heating element and will operate with the ignition switch in position II (ignition on). The heated rear window isn't constrained to an operational time limit.

PRINCIPLES OF OPERATION

Window Lift

The window lift relay coil is energized by an ignition feed from the central junction box (CJB). The energized relay provides a battery voltage feed to the left-hand (LH) and right-hand (RH) window lift switches.

Each window lift switch has 2 connections with its respective window lift motor; feed and return. These lines switch depending on the direction of travel requested using the switch. In each case, the motor is provided a ground path through its switch.

Each motor has thermal cut-out protection. If the window reaches the top or bottom of its travel, or hits an obstruction, the thermal cut-out will sense the increased load on the motor and cut the power supply to the motor brush contacts. Thermal cut-out time is between 3.5 to 5 seconds, with a re-start time of between 1 to 10 seconds.

Heated Windshield

Operation of the heated windshield is controlled by the heated windshield module. The heated windshield module is located behind the instrument cluster and receives an engine running signal from the engine control module (ECM). The heated windshield module also monitors the condition of the heated windshield switch. If the switch is pressed, a ground path is created. If both these signals are in place, the heated windshield module provides a feed to the heated windshield element until either;

- the switch is pressed a second time
- 8 minutes elapses
- or the engine is stopped.

Heated Rear Window

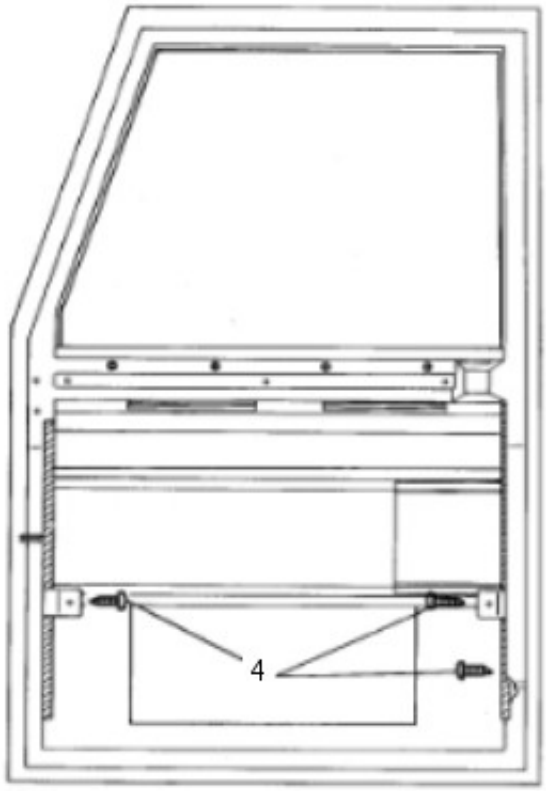
The heated rear window switch is located in the center console and is provided an ignition feed from the CJB. When the switch is pressed, a feed is provided to the heated rear window relay coil. The now energized heated rear window relay provides a battery voltage feed from the CJB to the heated rear window element.

Glass, Frames and Mechanisms - Front Door Window Glass

Removal and Installation

Removal

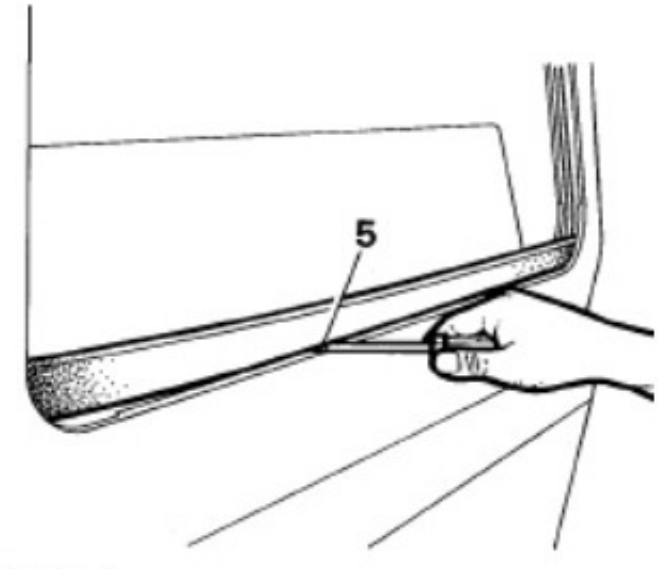
1. Remove front door reinforcement panel.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
2. Remove window regulator.
   For additional information, refer to: Front Door Window Regulator and Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation).
3. Push glass up to top of its travel and support with a suitable length of timber.
4. Remove 2 self tapping screws securing window glass runner on latch side of door and single screw from hinge side.



ST1976M

5. Taking care not to damage paint, prise exterior waist

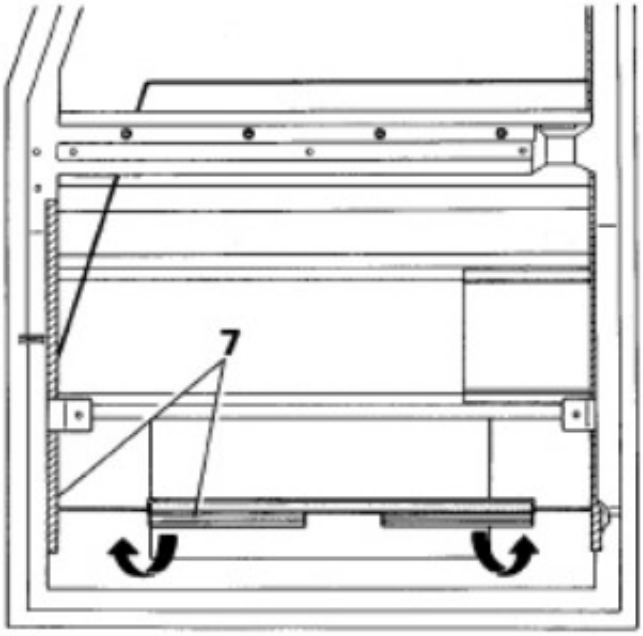
5. Taking care not to damage paint, prise exterior waist weather strip from door.



ST1966M

6. Remove timber support and lower glass to bottom of door.

7. Ease runner from glass at hinge side of door, lift glass over bottom edge of door and withdraw.



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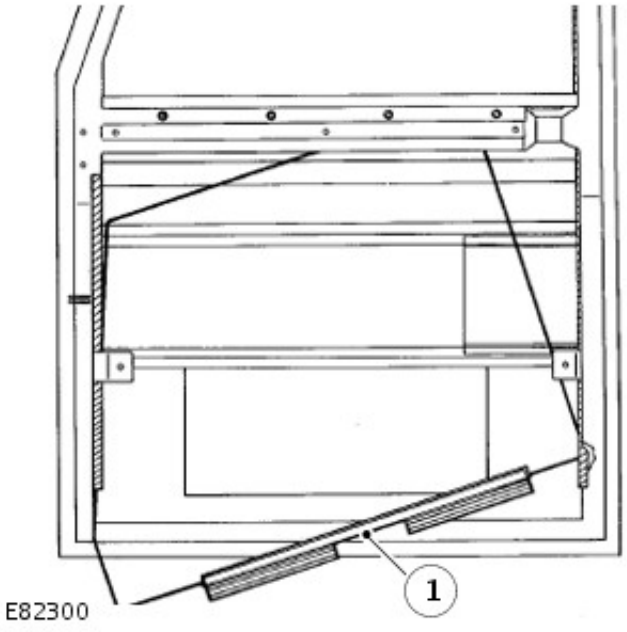
Installation

1. Insert glass into runners at an angle as illustrated.



2. Insert glass into runners at an angle as illustrated.

2. Whilst lifting glass, position it squarely in runners, raise to top of travel and insert timber support.

3. Secure hinge side runner with single screw ensuring that packing strip is in position.

4. Locate packing strip and secure opposite runner with 2 screws. Ensure that all 3 screw heads are well below bottom of runners to prevent damage to glass.

5. Locate regulator in window lift channels.

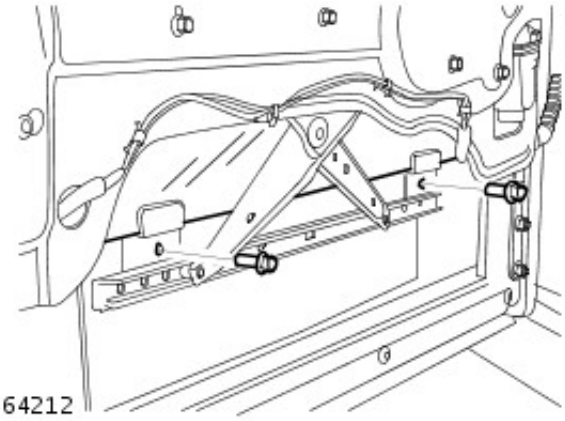
6. Install window regulator.
For additional information, refer to: Front Door Window Regulator and Motor (501-11 Glass, Frames and Mechanisms, Removal and Installation).

7. Install front door reinforcement panel.
For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).

Glass, Frames and Mechanisms - Front Door Window Regulator and Motor
Removal and Installation

Removal

1. Remove door trim panel. For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Remove plastic sheet.
3. Lower glass and remove 2 bolts securing door glass to regulator.

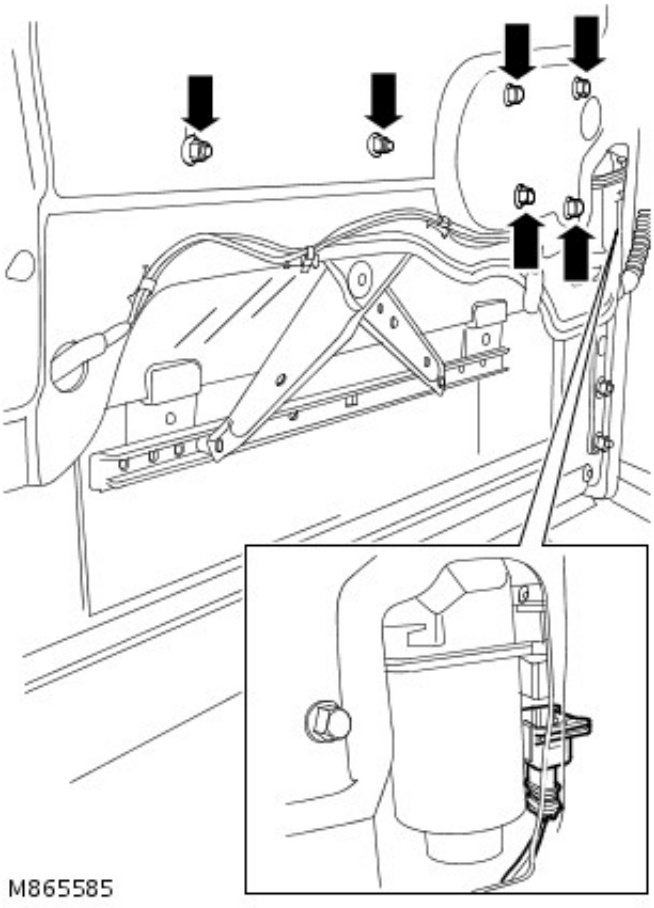

M764212

4. Release glass from regulator, raise and wedge in raised position.

M764213

5. Disconnect multiplug from motor.
6. Remove 4 bolts and 2 nuts securing motor and regulator

assembly.



7. Release and remove motor and regulator assembly.

Installation

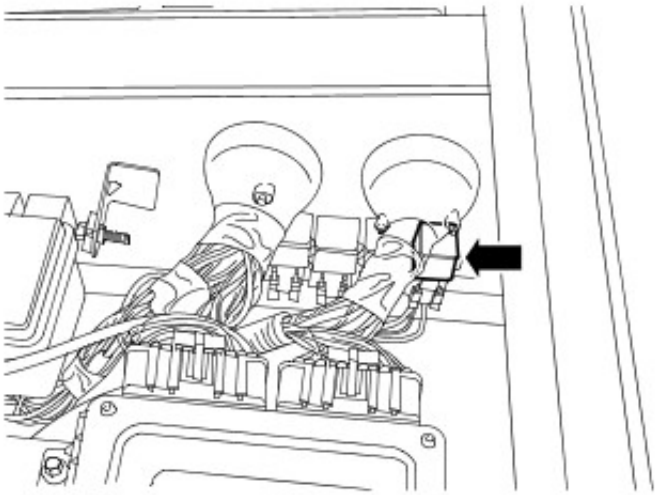
1. Install motor and regulator assembly, install nuts and bolts and tighten to 10 Nm (7 lbf.ft).
2. Connect multiplug to motor.
3. Remove wedges, lower glass and locate to regulator. Install bolts and tighten to 6 Nm (4 lbf.ft).
4. Raise and lower glass to check operation.
5. Install plastic sheet.
6. Install door trim panel. For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Glass, Frames and Mechanisms - Heated Windshield Relay

Removal and Installation

Removal

1. Remove front seat cushion.
2. Release clip and remove compartment cover.
3. Locate and release heated windshield relay from bracket.



M865586

4. Remove heated windshield relay.

Installation

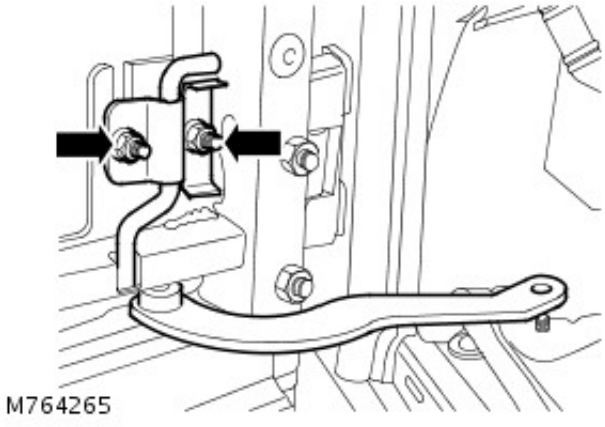
1. Fit heated windshield relay.
2. Fit heated windshield relay to mounting bracket.
3. Fit and secure cover.
4. Fit seat cushion.

Glass, Frames and Mechanisms - Rear Door Window Glass

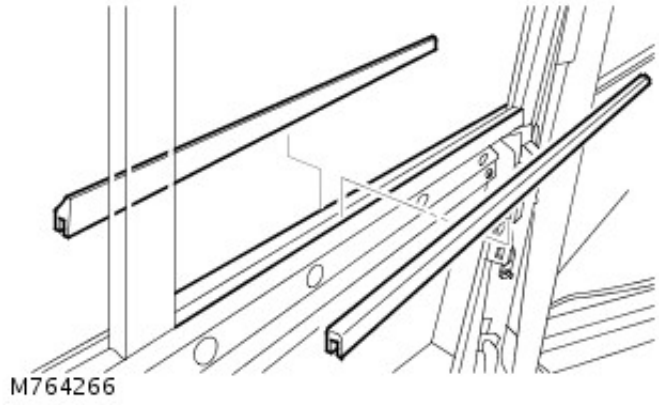
Removal and Installation

Removal

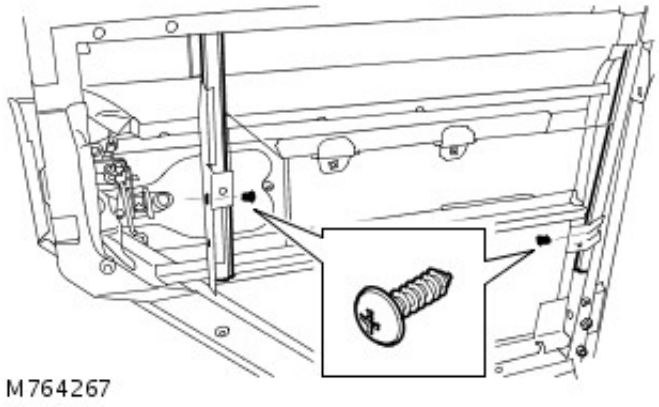
1. Remove rear door reinforcement panel.
   For additional information, refer to: Rear Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
2. Loosen 2 nuts and remove door check strap torsion bar and plate.



3. Remove check strap.
4. Remove inner and outer waist seal.



5. Remove screw from each glass channel.



6. Lower glass to bottom of door, lift over lower edge and withdraw from door.

Installation

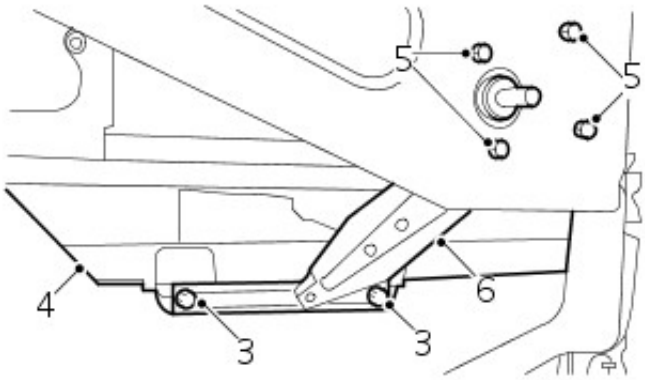
1. Insert glass into channels and carefully push to top of frame.
2. Secure glass channels with screws. Ensure screw heads are down below bottom of channels to prevent damage to glass.
3. Install inner and outer waist seal to door.
4. Install check strap.

5. Install check strap torsion bar and tighten nuts to 10 Nm (7 lbf.ft) .
6. Instal rear door mounting panel.
   For additional information, refer to: Rear Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).

Glass, Frames and Mechanisms - Rear Door Window Regulator and Motor
Removal and Installation

Removal

1. Remove rear door trim casing.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Carefully release plastic sheet from rear door.
3. Remove 2 bolts securing door glass to regulator.
4. Raise glass and secure with a suitable wedge.
5. Remove 4 bolts securing glass regulator assembly to door.
6. Manoeuvre regulator through access hole at bottom of the door.



M763141

Installation

1. Clean mating face of regulator and door glass.
2. Lubricate regulator with grease.
3. Position regulator in door and secure with bolts.
4. Remove wedge holding glass and align glass to regulator.
5. Secure glass to regulator and install and tighten bolts.
6. Install plastic sheet to rear door.
7. Install rear door trim casing.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

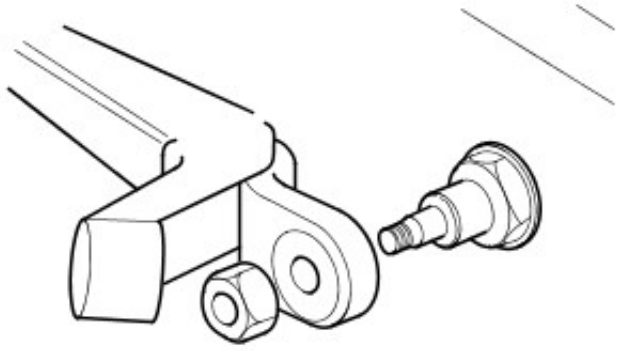
Glass, Frames and Mechanisms - Taildoor Window Glass

Removal and Installation

Removal

1. Remove spare wheel from taildoor.

2. Raise nut cover, remove nut and release wiper arm.

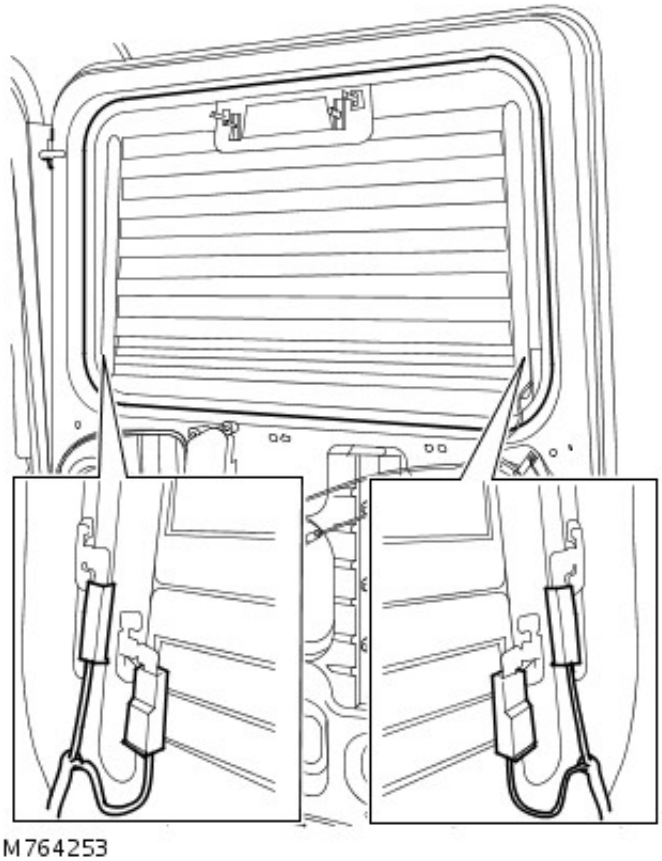


M764252

3. Open taildoor.

4. Remove high mounted stop lamp.
For additional information, refer to: High Mounted Stoplamp (417-01 Exterior Lighting, Removal and Installation).

5. Remove 4 connectors from heated rear window.



M764253

6. WARNING: Wear suitable eye protection when removing and refitting glass.

With assistance, from inside of vehicle apply pressure to glass, relieve seal lip and carefully remove glass.

7. CAUTION: Lay glass on felt covered supports and be careful not to damage the obscuration band. Do not stand on edge as this can cause chips which subsequently develop into

cracks.

Remove seal from glass.

Installation

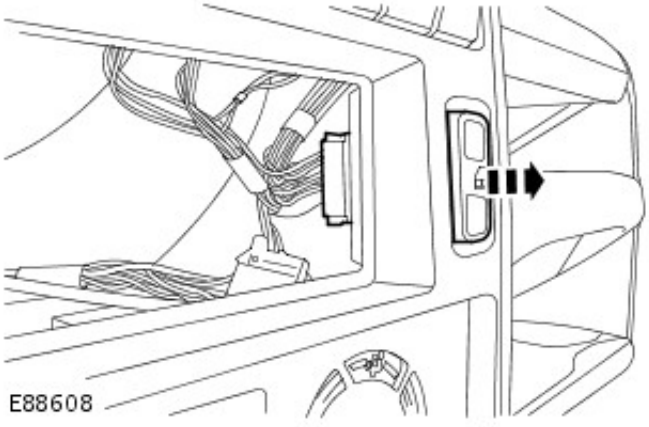
1. Clean glass and install seal. Ensure seal is fully located on glass.
2. Thoroughly clean the taildoor window mounting flange.
3. Install drawstring to seal.
4. Lubricate seal.
5. With assistance, position glass and seal to taildoor window aperture, locate lower edge and instal seal using drawstring.
6. Clean glass and check seal fit.
7. Fit connectors to heated rear window.
8. Install high mounted stop lamp.
   For additional information, refer to: High Mounted Stoplamp (417-01 Exterior Lighting, Removal and Installation).
9. Install wiper arm to spindle, align blade to window and tighten nut to 18 Nm (13 lbf.ft).
10. Install spare wheel and tighten nuts to 45 Nm (33 lbf.ft).

Glass, Frames and Mechanisms - Window Control Switch
Removal and Installation

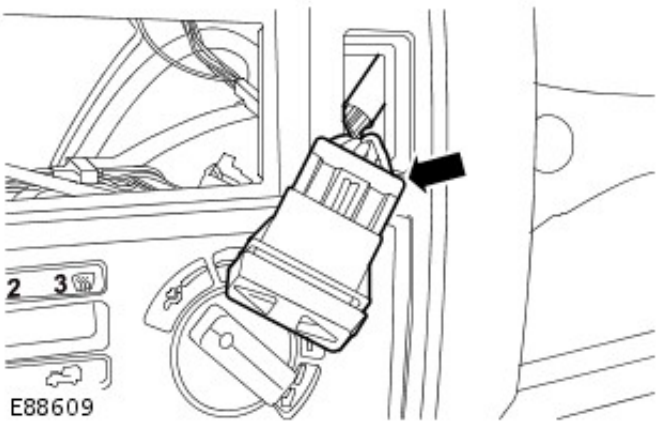
Removal

1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. NOTE: RH shown, LH similar.

   Release the window control switch.



4. Remove the window control switch.
   - Disconnect the electrical connector.



Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

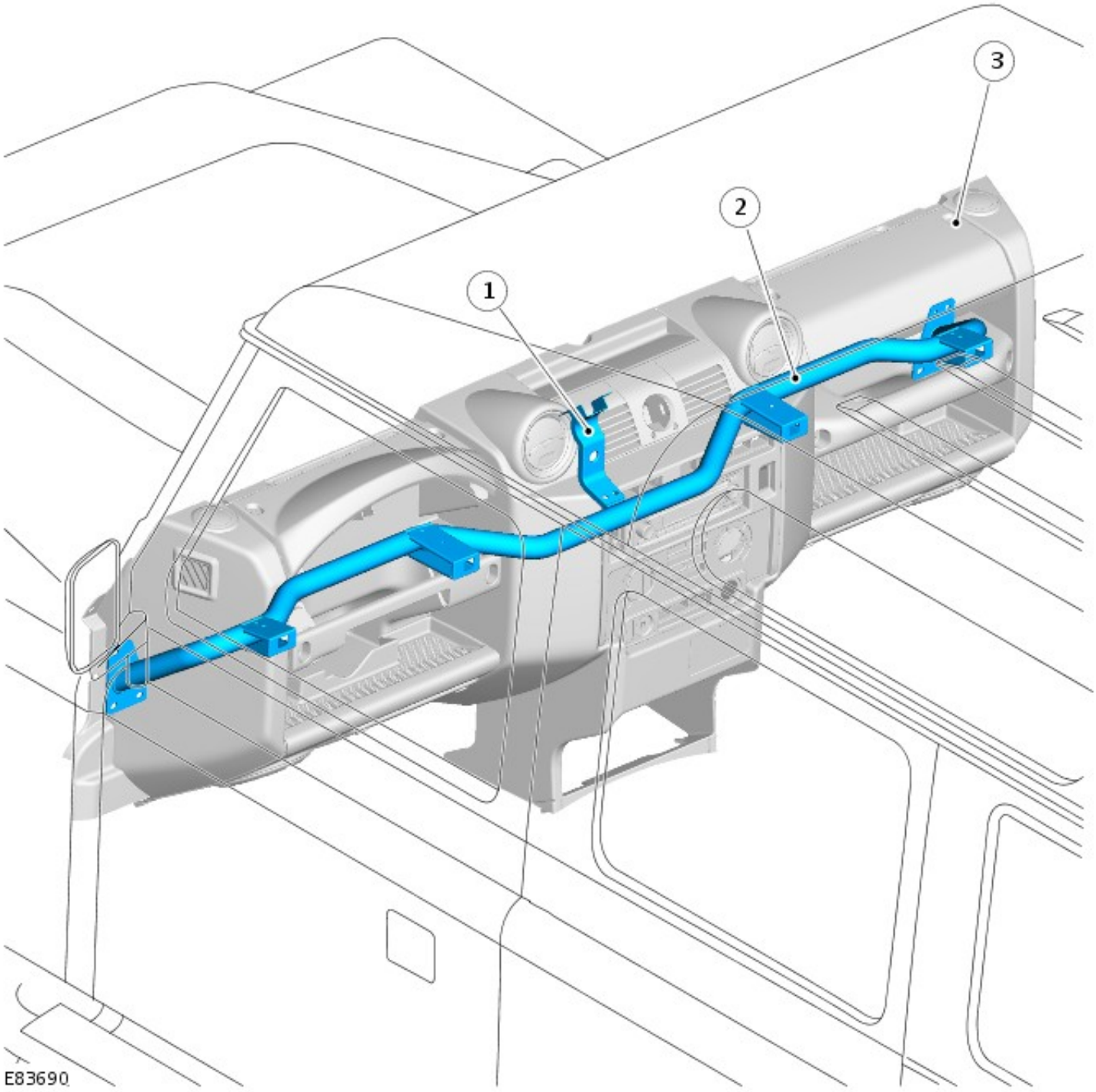
Instrument Panel and Console -

Torque specifications

Description	Nm	lb-ft
Instrument panel Torx 30 screw	2	1
Instrument panel Torx 20 screw	1	1
Instrument panel console	2	1
Grab handle	7	5

Instrument Panel and Console - Instrument Panel
Description and Operation

COMPONENT LOCATION



Item	Part Number	Description
1	-	Central support
2	-	Cross car rail
3	-	Instrument panel

OVERVIEW

Vehicles from 2007 model year feature an all new instrument panel. In addition to providing a location for various system switches and controls, the instrument panel also houses an all new instrument cluster and climate control system. For additional information, refer to:

Instrument Cluster (413-01 Instrument Cluster, Description and Operation),
Climate Control System (412-00 Climate Control System - General Information, Description and Operation),
Air Distribution and Filtering (412-01 Air Distribution and Filtering, Description and Operation).

Mounted behind the instrument panel is a tubular steel cross car rail. Three weld bolts are located on either end of the

cabin bulkhead to provide the mounting points for the cross car rail. If the cross car rail is removed, the nuts securing the rail in position must be discarded and replaced with new items.

The cross car rail is non-handed, meaning the same rail can be fitted to left-hand drive (LHD) and right-hand drive (RHD) vehicles.

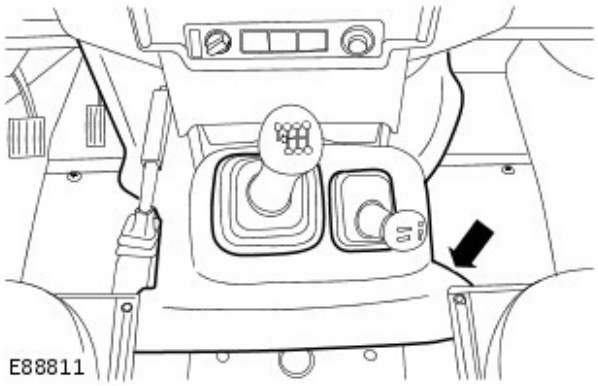
The cross car rail features 4 mounting brackets. The driver's side brackets provide mounting points for the instrument panel finisher; the passenger side brackets provide mounting points for the instrument panel grab handle. The mounting brackets contain expanding nuts, which must be replaced every time the instrument panel is removed.

A central support bracket is secured to the cross car rail by 2 plastic scrivets. A further plastic scrivet secures the top of the bracket to the cabin bulkhead. The central support bracket provides a mounting point for the audio system head unit and supports the in-board ends of the climate control system air ducts. The air ducts are secured to the central support bracket by a further 2 plastic scrivets. If any of the plastic scrivets are removed, they must be discarded and replaced with new items.

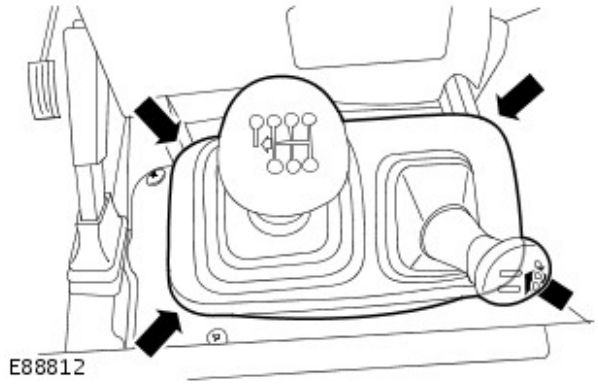
Instrument Panel and Console - Instrument Panel
Removal and Installation

Removal

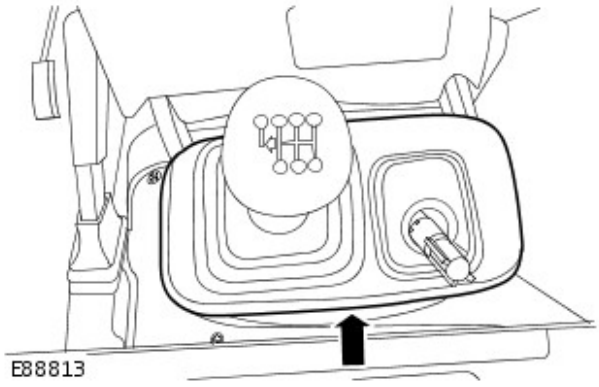
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the floor console.
   For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).
3. Remove the transmission cover panel floor covering.



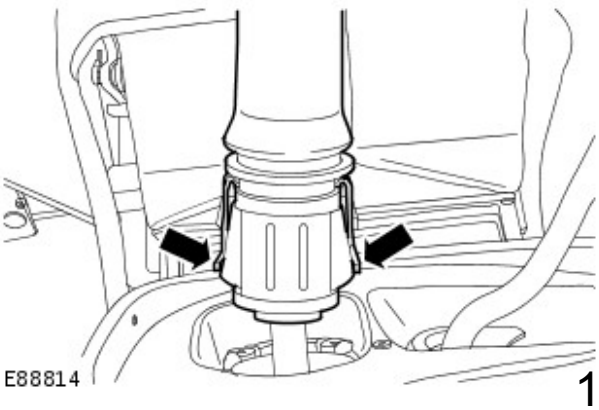
4. Remove the high/low gear selector lever.

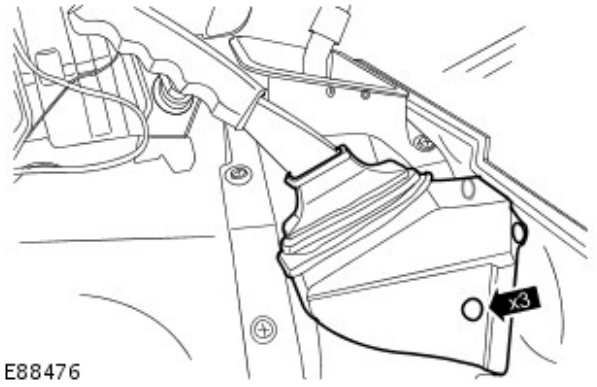


5. Release the gear shift lever.



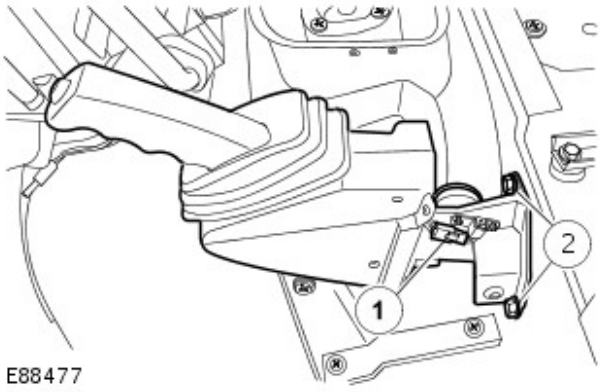
6. Remove the gear shift lever.
   - Release the 2 clips.





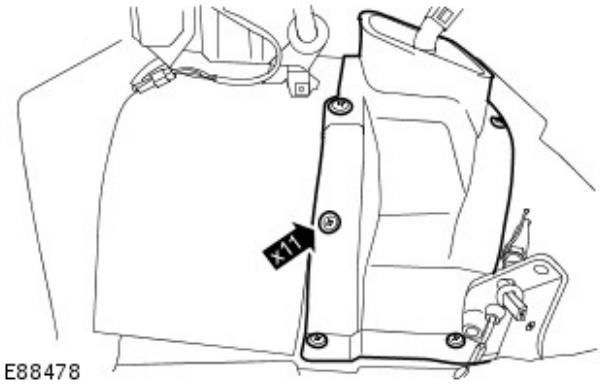
7. Release the parking brake lever gaiter.

- Remove the 3 clips.



8. Release the parking brake lever.

1. Disconnect the electrical connector.
2. Remove the 2 bolts.



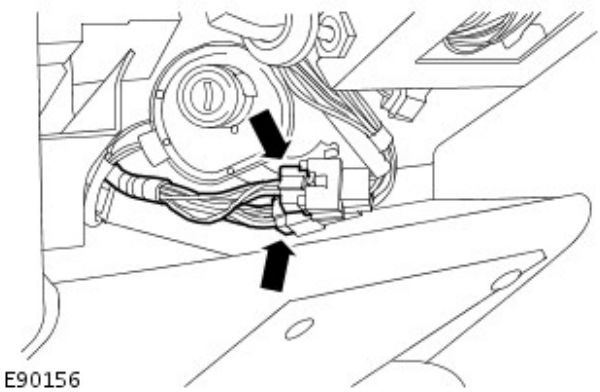
9. Remove the transmission cover panel.

- Remove the 11 screws.

10. Remove the steering wheel.
For additional information, refer to: Steering Wheel (211-04 Steering Column, Removal and Installation).

11. Remove the instrument cluster.
For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Removal and Installation).

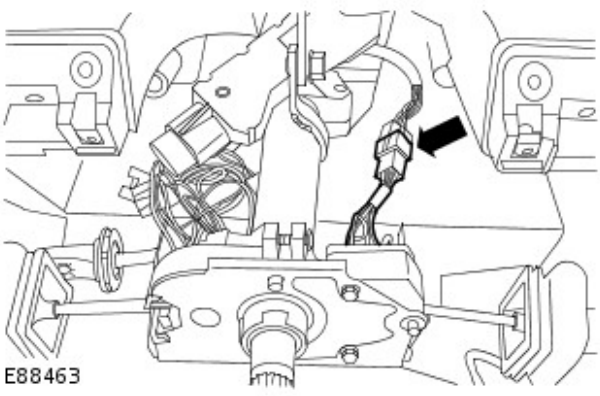
12. Remove the steering column shrouds.
For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).



13. Disconnect the 2 electrical connectors from the multifunction switch.

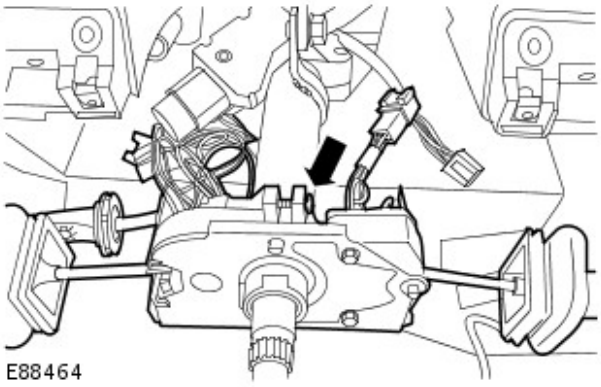
14. Disconnect the windshield wiper switch electrical

connector.


E88463

15. Remove the multifunction switch assembly.

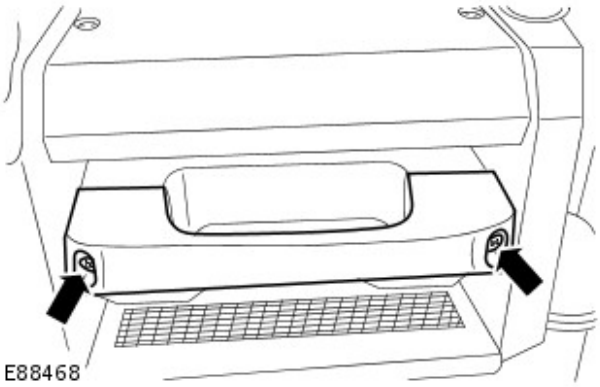
- Undo but do not remove the multifunction switch clamp screw.


E88464

16. Remove the instrument panel console.
For additional information, refer to: Instrument Panel Console (501-12 Instrument Panel and Console, Removal and Installation).

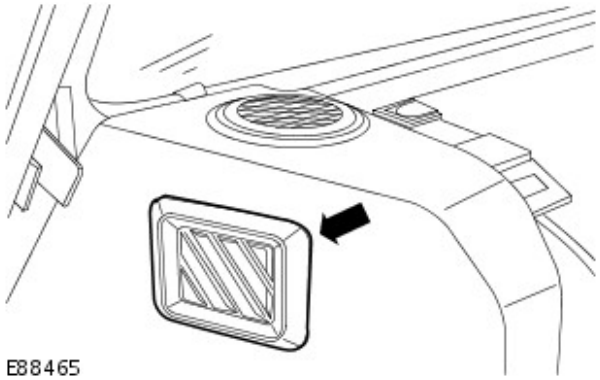
17. Remove the passenger side grab handle.

- Remove the 2 screws.

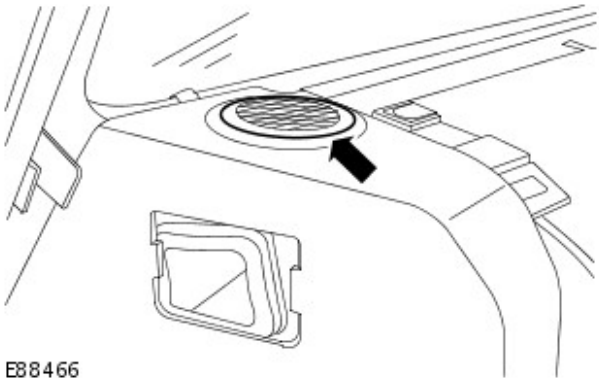

E88468

18. NOTE: Left-hand shown, right-hand similar.

Remove both side demister vent finishers.

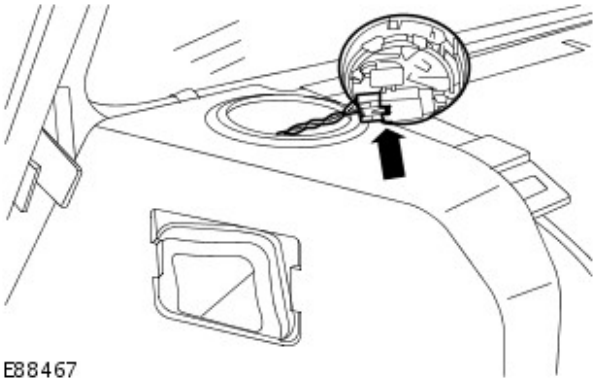

E88465

19. NOTE: Left-hand shown, right-hand similar.


E88466

Release both instrument panel speakers.

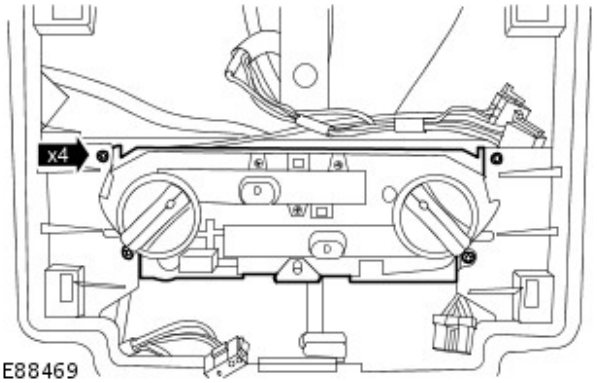
20. NOTE: Left-hand shown, right-hand similar.


E88467

Remove both instrument panel speakers.

- Disconnect the electrical connector.

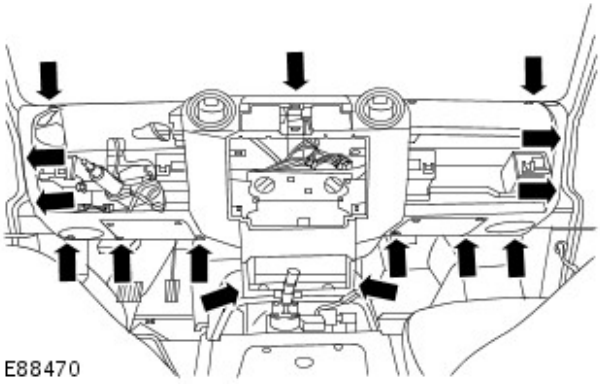
21. Release the climate control switch panel.



E88469

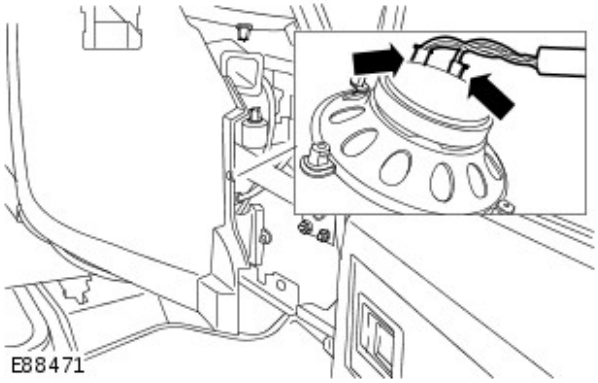
- Remove the 4 screws.

22. Release the instrument panel.


E88470

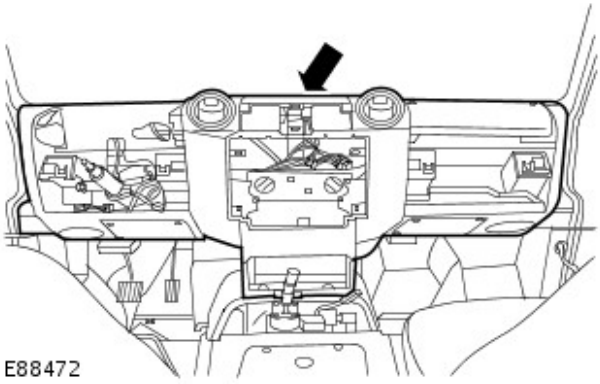
- Remove the 15 screws.

23. NOTE: RH shown, LH similar.



Disconnect the 4 electrical connectors from the instrument panel speakers.

24. With assistance, remove the instrument panel.

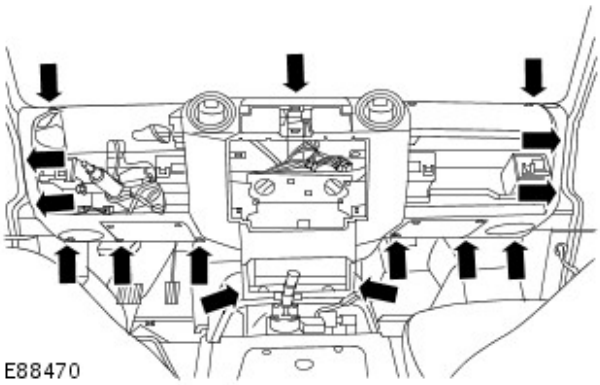


Installation

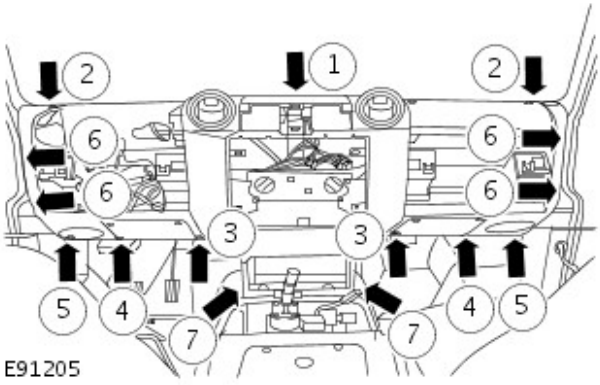
1. With assistance, install the instrument panel.

2. Connect the 4 electrical connectors to the instrument panel speakers.

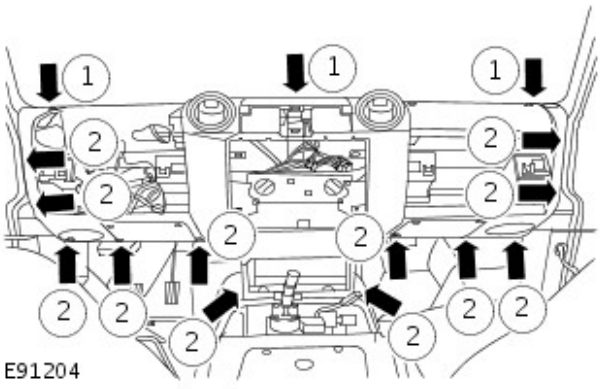
3. Loosely install the instrument panel screws.



4. Tighten the screws in the order indicated in the illustration shown.



5. Tighten the screws.



1. Tighten to 2 Nm (1 lb.ft).
2. Tighten to 1 Nm (1 lb.ft).

6. Secure the climate control switch panel.

- Install the 4 screws.

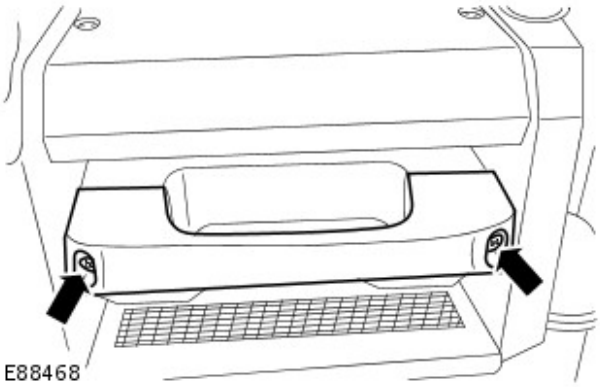
7. Install both instrument panel speakers.

- Connect the electrical connectors.

8. Install both side demister vent finishers.

9. Install the passenger side grab handle.

- Tighten to 7 Nm (5 lb.ft).



10. Install the instrument panel console.
For additional information, refer to: Instrument Panel Console (501-12 Instrument Panel and Console, Removal and Installation).

11. Install the multifunction switch assembly.

- Connect the 3 electrical connectors.
- Fully tighten the multifunction switch clamp screw.

12. Install the steering column shrouds.
For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).

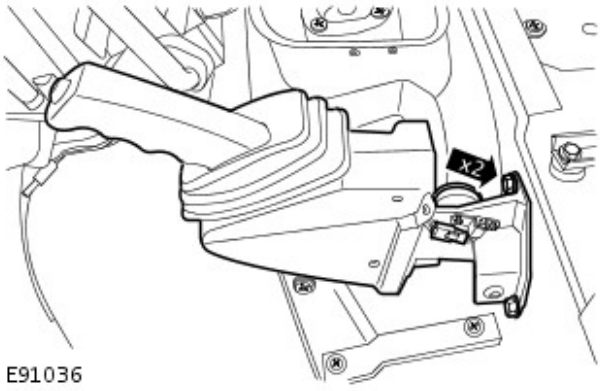
13. Install the instrument cluster.
For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Removal and Installation).

14. Install the steering wheel.
For additional information, refer to: Steering Wheel (211-04 Steering Column, Removal and Installation).

15. Install the transmission cover panel.

- Install the 11 screws.

16. Secure the parking brake lever.



- Tighten to 25 Nm (18 lb.ft).

17. Attach the parking brake lever gaiter.

- Install the 3 clips.

18. Install the gear shift lever.

19. Attach the gear shift lever.

20. Install the high/low gear selector lever.

21. Install the transmission cover panel floor covering.

22. Install the floor console.
For additional information, refer to: Floor Console (501-12 Instrument Panel and Console, Removal and Installation).

23. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

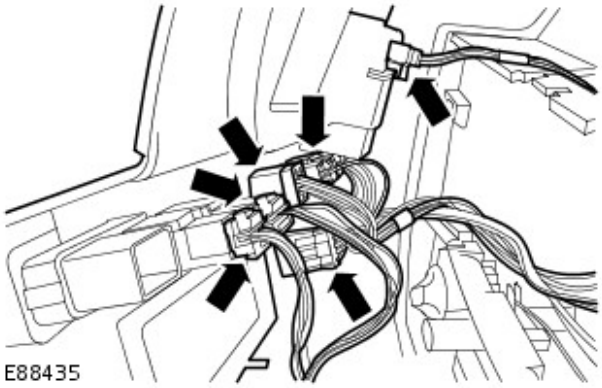
Instrument Panel and Console - Instrument Panel Console
Removal and Installation

Removal

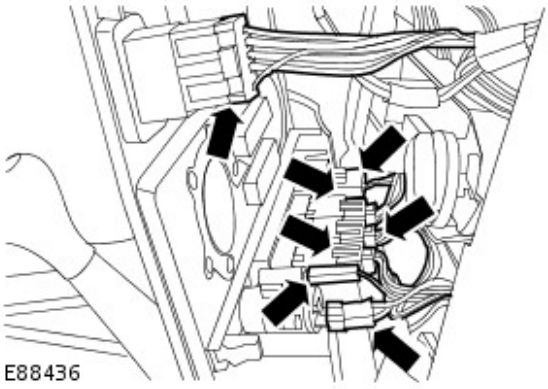
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the audio unit.
   For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).
3. Release the instrument panel console.
   - Remove the 2 screws.

E88434

4. Disconnect the 6 electrical connectors from the instrument panel console.


E88435

5. Remove the instrument panel console.
   - Disconnect the 7 electrical connectors.


E88436

Installation

1. To install, reverse the removal procedure.
2. Connect the battery ground cable.
   For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Instrument Panel and Console - In-Vehicle Crossbeam

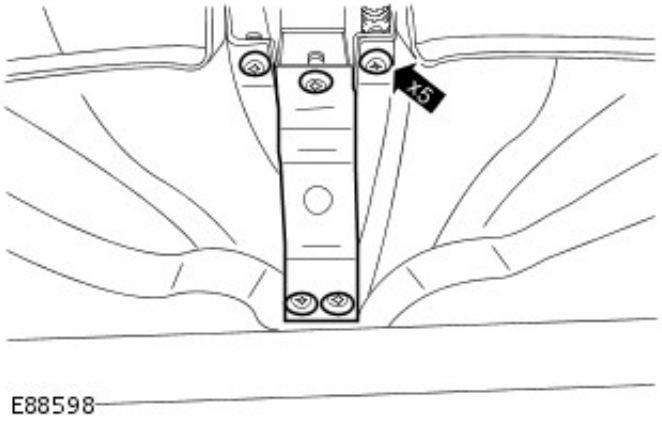
Removal and Installation

Removal

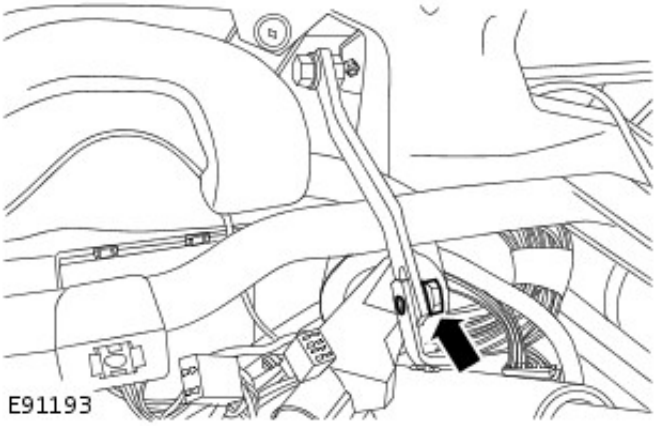
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the instrument panel.
   For additional information, refer to: Instrument Panel (501-12 Instrument Panel and Console, Removal and Installation).
3. NOTE: Make sure the clips are discarded.

   Remove the audio unit support bracket.

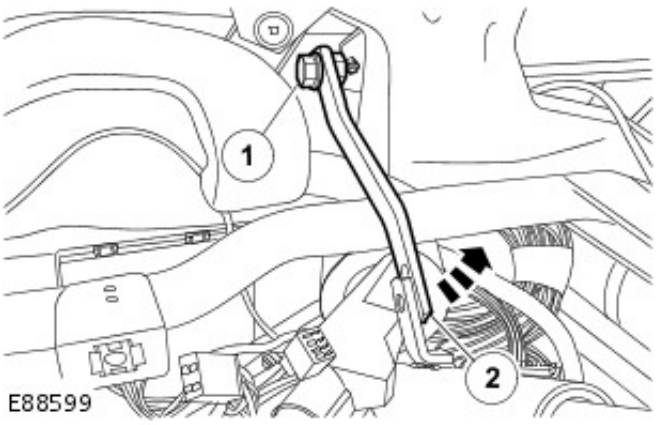
   - Remove and discard the 5 clips.



4. Release the steering column bracket.
   - Remove the bolt.

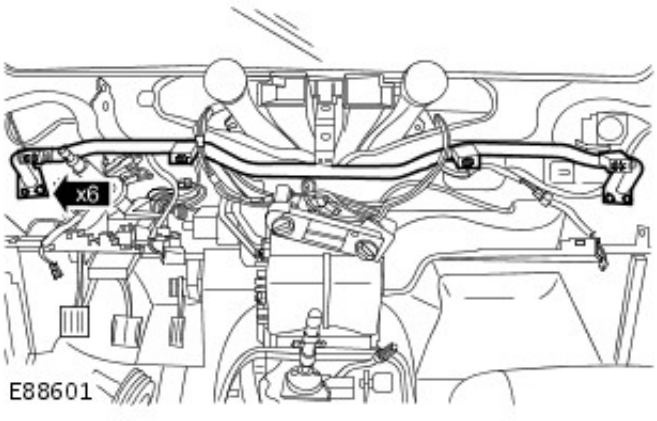


5. Reposition the steering column bracket.
   1. Undo but do not remove the bolt.
   2. Reposition the bracket.



6. Remove the in-vehicle crossbeam.

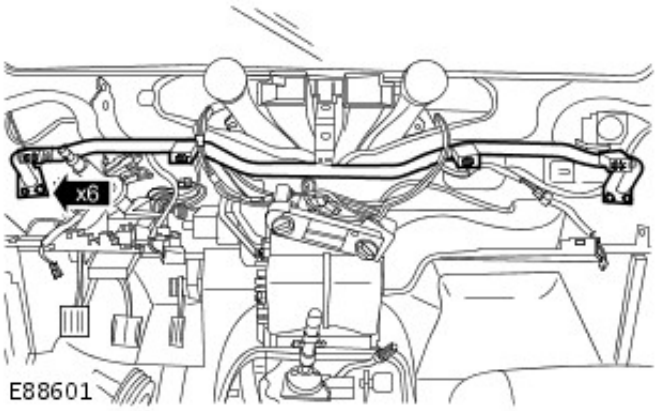
- Remove and discard the 6 nuts.



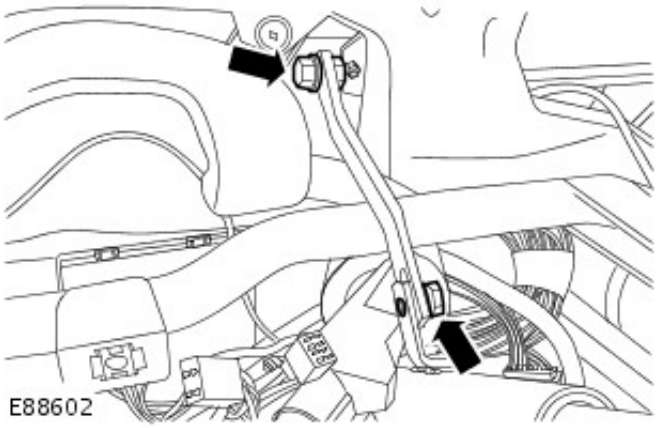
Installation

1. To install, reverse the removal procedure.

1. Tighten to 23 Nm (17 lb.ft).



2. Tighten to 22 Nm (16 lb.ft).



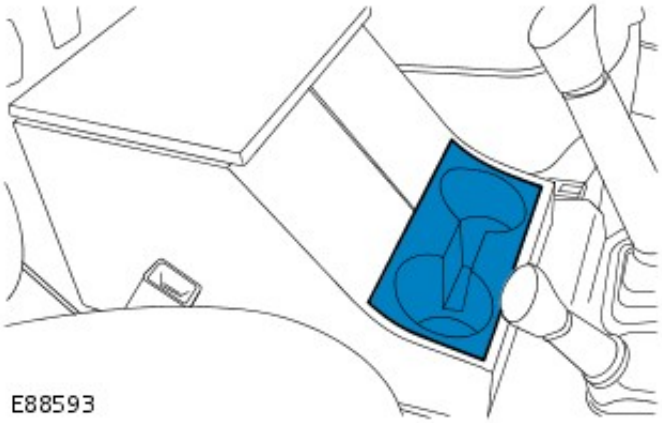
3. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Instrument Panel and Console - Floor Console

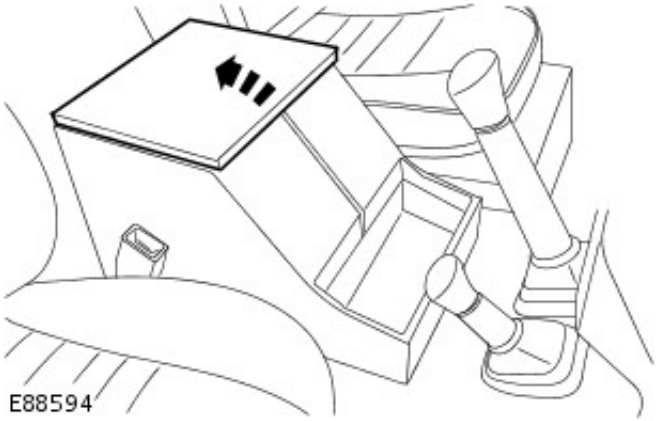
Removal and Installation

Removal

1. Remove the cup holder.

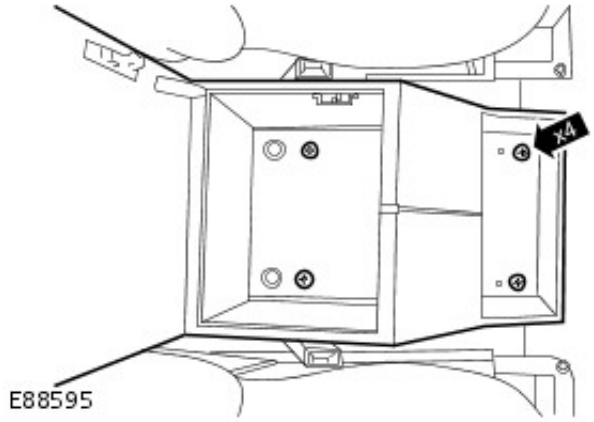


2. Open the floor console lid.



3. Remove the floor console.

- Remove the 4 screws.



Installation

1. To install, reverse the removal procedure.

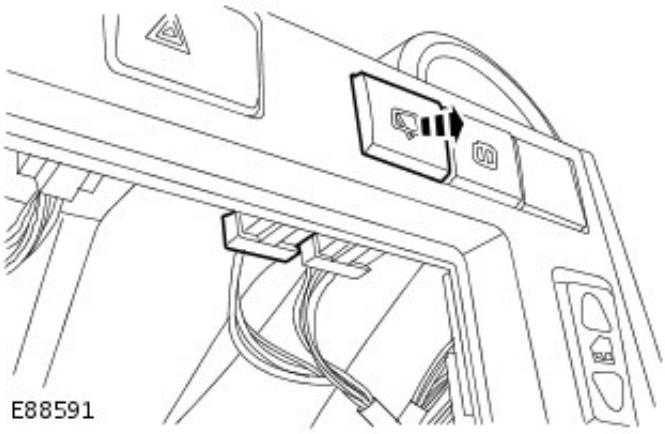
Instrument Panel and Console - Instrument Panel Switches
Removal and Installation

Removal

- NOTE: Rear window wiper switch shown, other instrument panel switches similar.

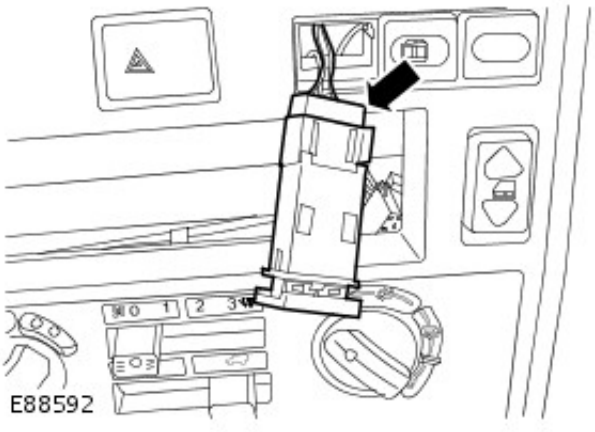
1. Remove the audio unit.
For additional information, refer to: Audio Unit (415-01A Audio Unit, Removal and Installation).

2. Release the instrument panel switch.



3. Remove the instrument panel switch.

- Disconnect the electrical connector.



Installation

1. To install, reverse the removal procedure.

Handles, Locks, Latches and Entry Systems -

Torque specifications

Discription	Nm	lb.ft
Taildoor latch	10	7

Handles, Locks, Latches and Entry Systems - Handles, Locks, Latches and Entry Systems

Description and Operation

CENTRAL DOOR LOCKING (CDL) FROM 2002 MY

The Central Door Locking (CDL) system is a new feature for 2002MY Defender.

• NOTE: CDL operates all doors on Station Wagon and County Station Wagons. On all other Defender 2002MY variants, CDL operates on the driver and front and rear passenger doors only.

CDL operates on all doors, including the tail door and is operated by pressing the appropriate button on the remote handset, using the vehicle key in the drivers door lock or using the drivers door sill button.

The CDL system introduces electrically operated door latches which are controlled by the anti-theft alarm ECU, located behind the instrument pack. The anti-theft ECU receives a permanent power supply from fuse 6 in the passenger compartment fuse box. Each CDL latch motor is connected by two wires to the anti-theft ECU which alternately supplies power and earth connections to drive each motor to the lock or unlock positions.

If the latch motors are continually operated in a short period of time, the anti-theft ECU will suspend all CDL latch motor operation for 15 seconds to prevent the motors from overheating. Before suspension occurs the anti-theft ECU ensures that all the doors are left in the unlocked condition.

If the vehicle is locked, and the key is in the ignition switch or the ignition is on and the anti-theft alarm ECU inertia switch is tripped, all doors will be unlocked immediately and the hazard warning lamps will operate. To prevent accidental relocking, all latch motors will be inhibited until the anti-theft ECU senses that the drivers door is opened with the key removed from the ignition switch.

Locking of the vehicle using the remote handset is inhibited with the key in the ignition switch.

Slam Locking

With the introduction of CDL, slam locking of the drivers door is disabled. If an attempt is made to slam lock the vehicle, the anti-theft alarm ECU will unlock all doors.

CDL Using the Drivers Door Sill Button

Each door has a sill button to allow that door to be individually locked from inside the vehicle. The drivers door sill button has additional functionality which allows all doors to be locked from inside the vehicle from this one button.

When the driver door sill lock button is depressed, the CDL system enters a sill locked state, where all doors are locked but immobilisation and perimetric and volumetric sensing is suspended. CDL using the drivers sill lock button can be achieved with or without the key in the ignition switch and without the ignition being on.

If the CDL is in the sill locked state and the lock button on the remote handset is pressed, the volumetric and perimetric functions of the alarm system will become active and active engine immobilisation will be invoked.

CDL Using the Key

The driver and the passenger front doors are fitted with key barrel locks. Using the vehicle key in the passenger door will only lock or unlock that door. Using the key in the drivers door will operate the CDL system and lock or unlock all doors.

• NOTE: The passenger door key barrel is connected to the door latch and has no electrical input to the anti-theft alarm ECU. The driver door key barrel is also connected to the door latch and its operation is monitored by the ECU only via the latch motor and the two wires connected to it.

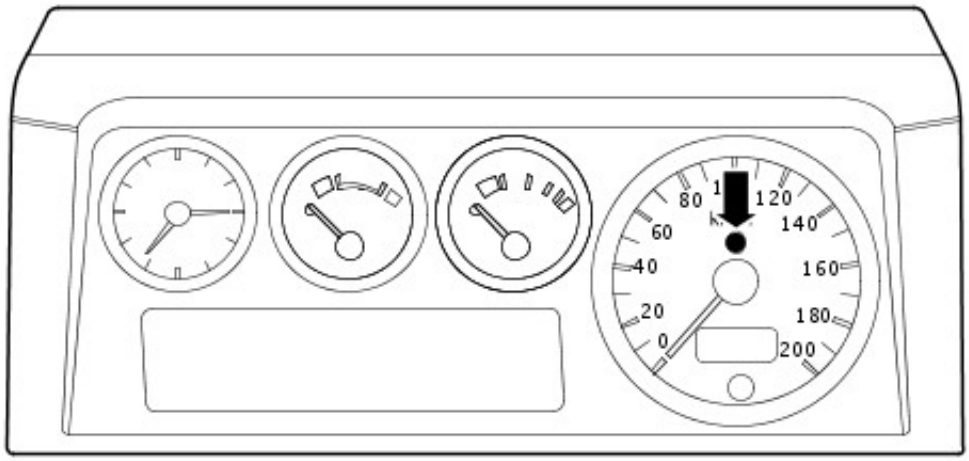
When the vehicle is locked using the key in the drivers door, only CDL and perimetric protection is invoked. Volumetric protection and active immobilisation is not initiated.

CDL Using the Remote Handset

The remote handset has two buttons; lock and unlock. A single press on the lock button will lock all doors and invoke perimetric and volumetric protection and active immobilisation. Remote locking is inhibited if the transponder coil senses that the key is in the ignition switch.

When the vehicle is locked, a single press of the unlock button will unlock all doors and disable perimetric and volumetric protection. Immobilisation is only disabled using the transponder coil and the remote handset or the EKA procedure.

Security LED



M865555

In addition to the alarm system status indications, the security LED also displays CDL system status.

The system confirms that the drivers door is open by illuminating the LED for the 10 second confirmation period. If any other door or the hood is open, the LED remains unlit for the 10 second confirmation period. After the 10 second confirmation period the LED reverts to the slow flash deterrent mode if the alarm is armed.

Interior Lamp Functionality

The anti-theft alarm ECU controls the interior lamp functionality. When the lamps are extinguished, they fade out to the off condition over a 2 second period.

The lamps are turned on by:

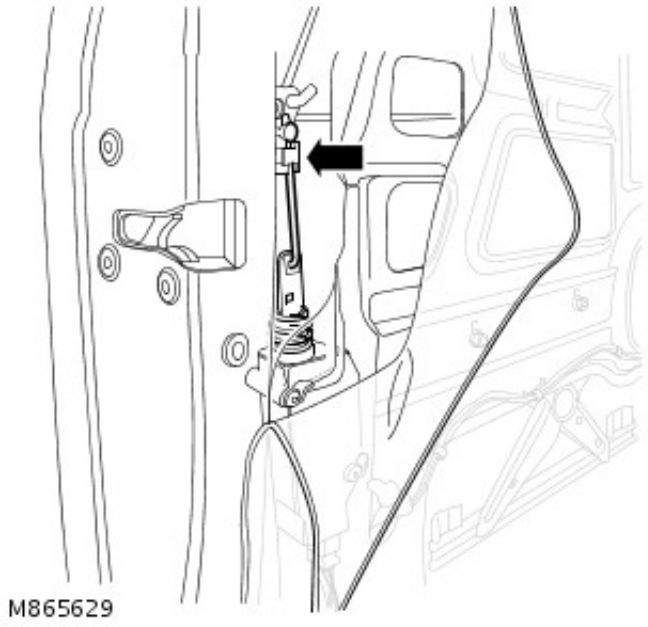
- Disarming the alarm using the remote handset
- Opening any door.

When the lamps are on, they will be extinguished by the following actions:

- If all doors are closed, the lamps will be extinguished after a 15 second delay period.
- If any door is left open, the lamps will be extinguished after an 8 minute delay period.
- If one of the above delay periods is active and the ignition is switched on or the alarm is armed, the lamps will be extinguished.

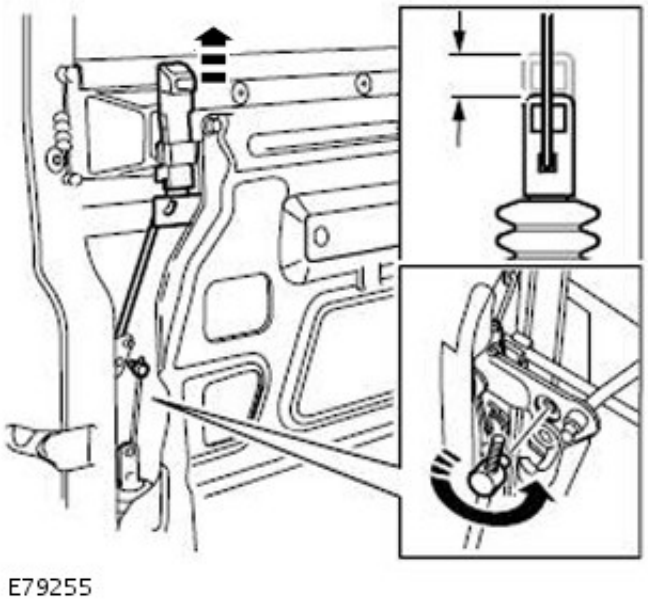
Handles, Locks, Latches and Entry Systems - Latch Cable Adjustment

General Procedures


M865629

1. Remove door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Carefully peel back plastic sheet to expose mechanism.
3. Release clip and detach solenoid link from latch.

4. Ensure sill button is fully raised.
5. Fully extend solenoid actuator then lower 3.5 mm ± 1.00 mm.
6. Whilst holding actuator in this position, adjust length of link, until link pin is aligned with hole in latch lever.
7. Connect link and secure with clip.


E79255

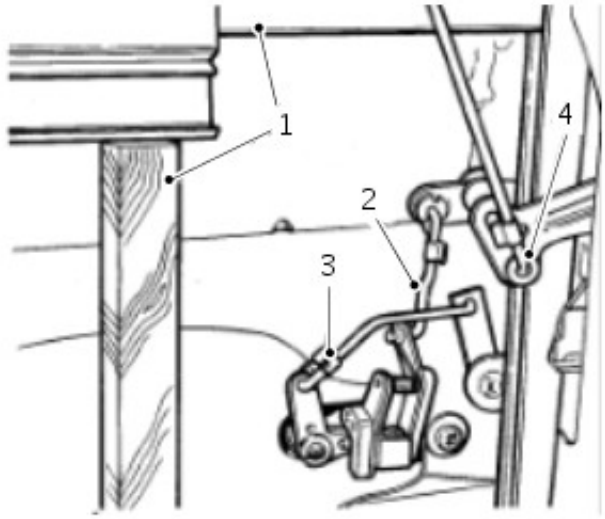
8. Secure plastic sheet.
9. Instal door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Front Door Latch

Removal and Installation

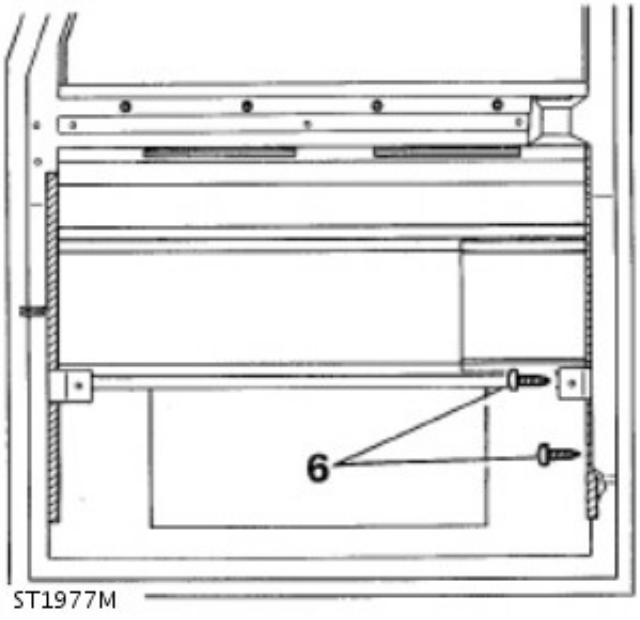
Removal

1. Remove door reinforcing panel and support glass with timber.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
2. Disconnect control rod from handle operating lever.
3. Disconnect control rod from locking lever on handle.
4. Disconnect push button control rod and linkage from latch mechanism.



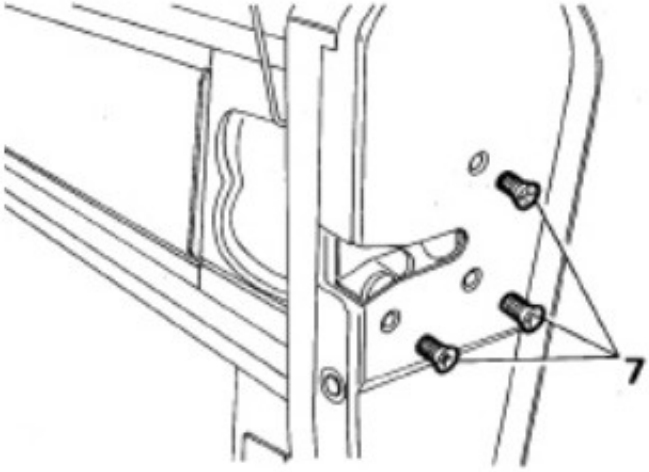
ST1983M

5. Remove 2 screws and remove handle assembly from door.
6. Remove 2 self-tapping screws retaining lower end of window glass runner.



ST1977M

7. Remove 3 screws securing latch assembly to door.



ST1975M

8. Whilst taking care not to damage runner, ease runner away from latch and manoeuvre latch assembly from door.

Installation

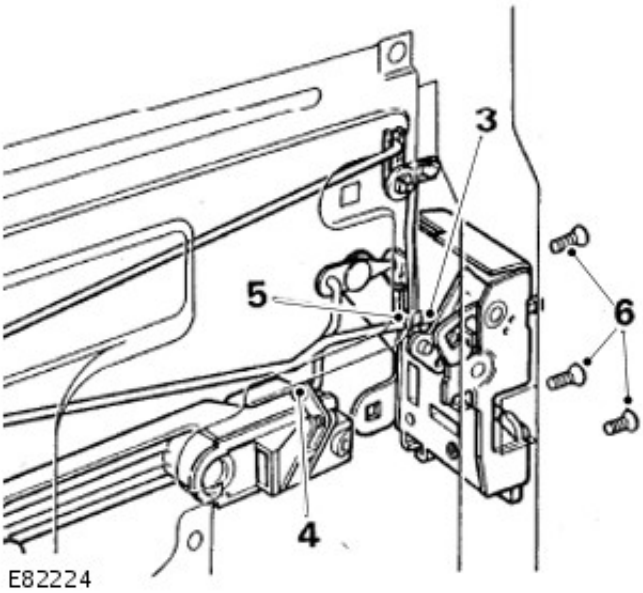
1. Carefully ease window runner away, sufficiently to enable latch to be located into position.
2. Secure latch to door with 3 screws.
3. Secure window runner with 2 screws ensuring that packing strip is in position and that screw heads are below bottom of runner to prevent damage to glass.
4. Install handle with 2 screws, ensuring that bezels are in position.
5. Connect control rod to handle operating lever and secure with spring clip.
6. Connect control rod to locking lever and retain with spring clip.
7. Connect push button control rod and linkage to latch lever and secure with spring clip.
8. Install mounting panel.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Rear Door Latch

Removal and Installation

Removal

1. Remove door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel-back sufficient of plastic sheet to reveal latch.
3. Release remote control lever rod from latch assembly.
4. Disconnect door outer handle control rod from latch assembly.
5. Disconnect door locking button remote control rod from latch mechanism.
6. Remove 3 retaining screws and withdraw latch assembly from door.



Installation

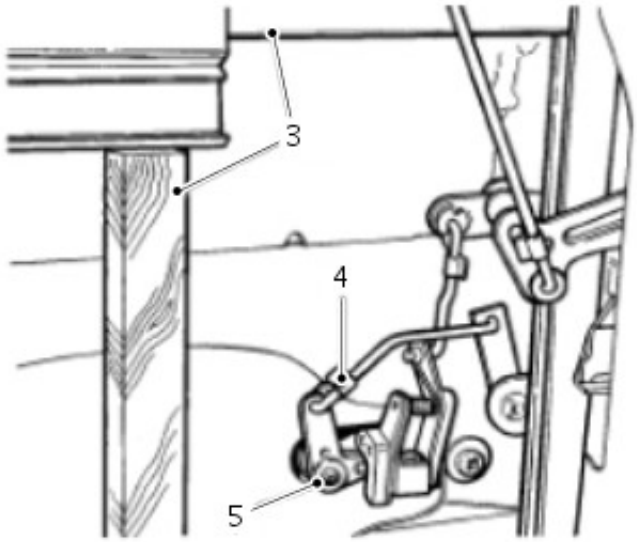
1. Install latch assembly to door and secure with 3 screws, noting that uppermost screw is longer.
2. Connect remote control levers to latch mechanism reversing instructions 3, 4 and 5.
3. Re-seal plastic sheet and install door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Door Lock Cylinder

Removal and Installation

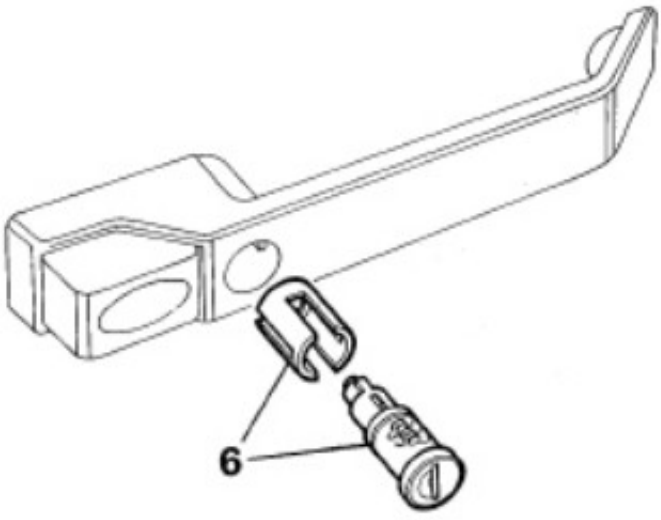
Removal

1. Remove door trim panel and plastic sheet.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Remove reinforcement panel.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
3. Raise and support glass to gain access to latch mechanism.
4. Release spring clip and disconnect rod from lock operating lever.
5. Remove single screw and withdraw lock lever assembly.



ST1981M

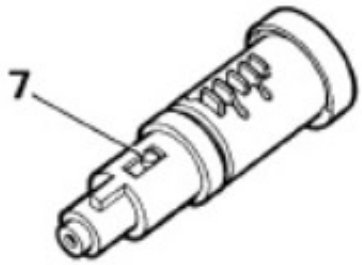
6. Withdraw lock barrel from exterior door handle complete with locking sleeve.



ST1980M

7. To remove barrel from plastic retaining sleeve, depress

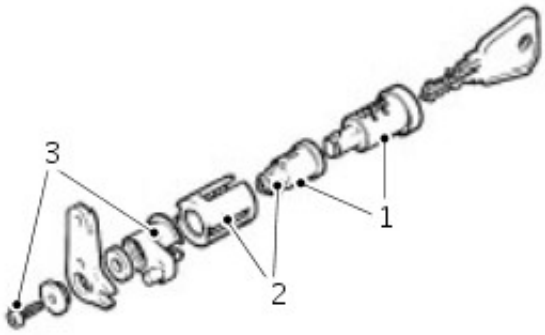
spring loaded button and withdraw sleeve.



ST1979M

Installation

- NOTE: If a new barrel is being installed, check that number on barrel coincides with number on accompanying key.



ST1978M

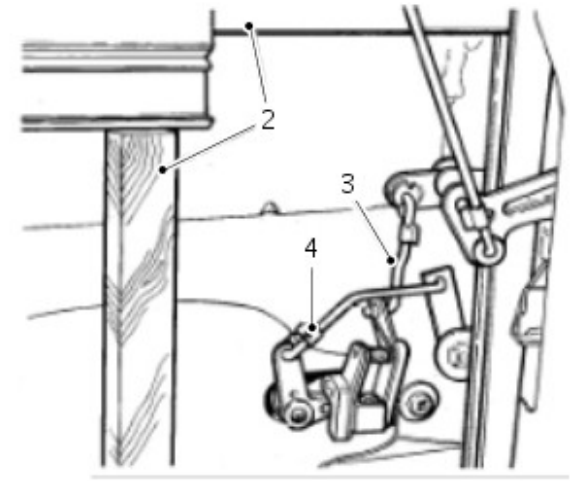
1. Push plastic retaining sleeve over barrel until spring loaded peg locks it into position.
2. Install barrel and plastic sleeve assembly to locking sleeve and insert into exterior handle reversing instruction 6.
3. Assemble lock lever components as illustrated and from inside of door panel, install them to barrel assembly with single screw.
4. Connect operating rod to lock lever and secure with spring clip, reversing instruction 4.
5. Install front door reinforcement panel.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
6. Install plastic sheet.
7. Install door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Exterior Front Door Handle

Removal and Installation

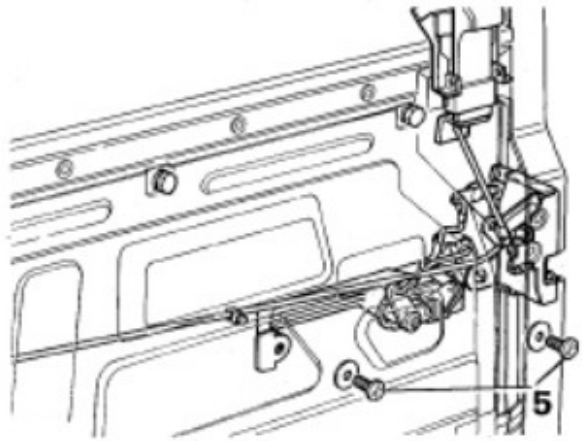
Removal

1. Remove door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Remove door reinforcement panel and support glass with timber.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).
3. Disconnect operating rod from handle mechanism.
4. Disconnect rod from locking barrel lever.



ST1982M

5. Remove 2 screws and withdraw handle assembly.



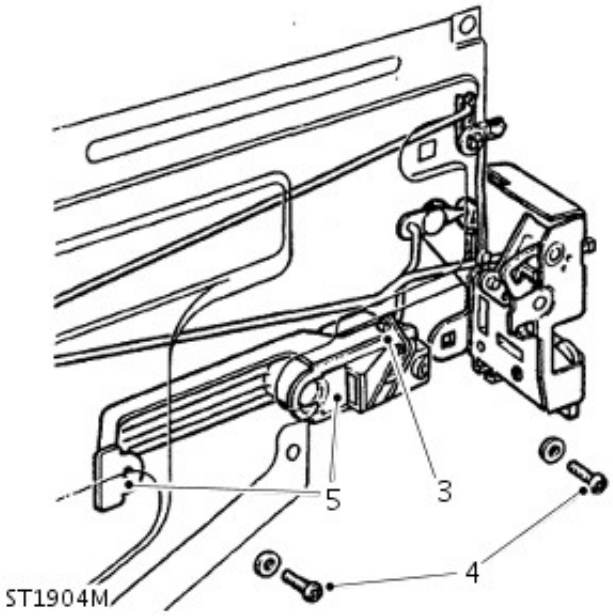
ST1970M

Installation

1. Install handle to door ensuring that two bezels are in position - flat faces towards door, and secure with 2 screws.
2. Connect rod to handle operating lever and secure with spring clip.
3. Connect rod to locking barrel lever and retain with spring clip.
4. Install door reinforcement panel.
   For additional information, refer to: Front Door Reinforcement Panel (501-03 Body Closures, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Exterior Rear Door Handle

Removal and Installation



Removal

1. Remove door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel back sufficient of plastic sheet to gain access to handle mechanism.
3. Disconnect actuating rod from handle operating lever.
4. Remove 2 screws and withdraw handle and bezels.

Installation

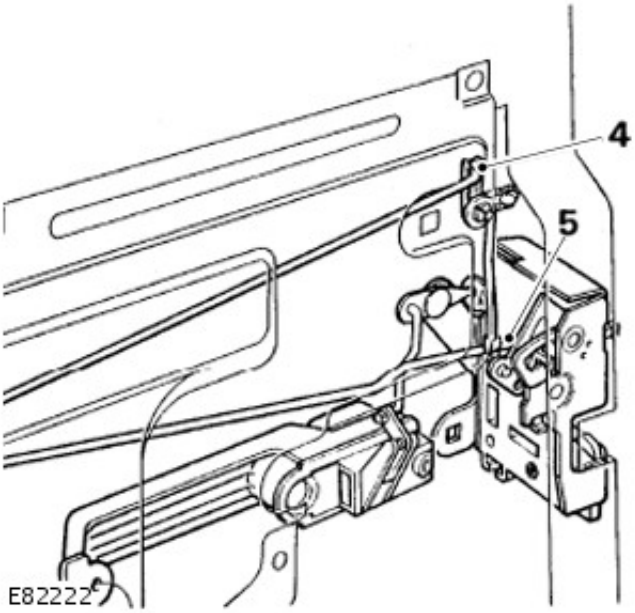
1. Install handle to door ensuring that both bezels are in position - flat faces towards door and secure with 2 screws.
2. Connect actuating rod to handle operating lever and secure with spring clip.
3. Re-seal plastic sheet.
4. Install door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Interior Rear Door Handle

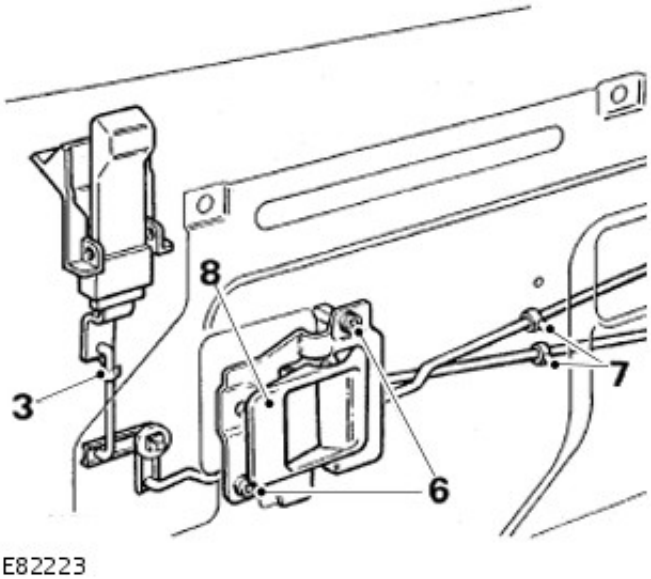
Removal and Installation

Removal

1. Remove door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel-back sufficient of plastic sheet to gain access to remote lever.
3. Remove spring clip and disconnect control rod from push button.
4. Release spring clip and disconnect short locking button control rod from latch mechanism.
5. Disconnect long remote control rod from latch assembly.



6. Remove 2 screws securing remote control lever to mounting panel.
7. Release control rods from plastic retaining clips located in mounting panel.
8. Withdraw remote control lever and rods from door.



Installation

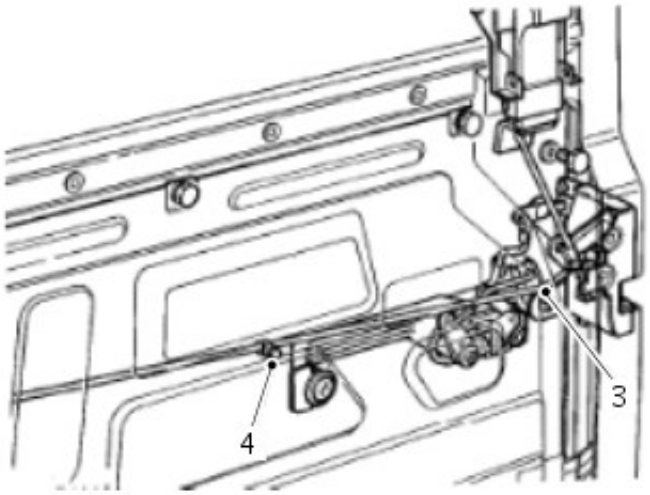
1. Install plastic retaining clips to rod assembly into position and secure with 2 screws.
2. Connect control rods to latch assembly and secure with clips.
3. Install plastic retaining rod clips to mounting panel.
4. Connect control rod to push button and secure with clip.
5. Re-seal plastic sheet and install door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Interior Front Door Handle

Removal and Installation

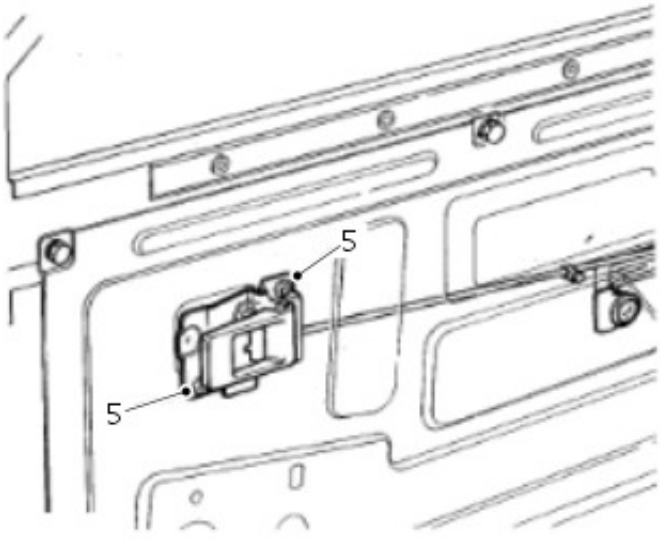
Removal

1. Remove door trim casing.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel back sufficient of plastic sheet to gain access to remote lever.
3. Release spring clip and disconnect control rod from latch mechanism.
4. Release control rod from plastic clip in mounting panel.



ST1971M

5. Remove 2 screws securing remote control lever to mounting panel and withdraw lever and control rod.



ST1972M

Installation

1. Feed control rod into position and loosely secure lever to mounting panel with 2 screws.
2. Connect control rod to latch mechanism and secure with spring clip.
3. Tighten control lever retaining screws.
4. Secure control rod to plastic clip in mounting panel.

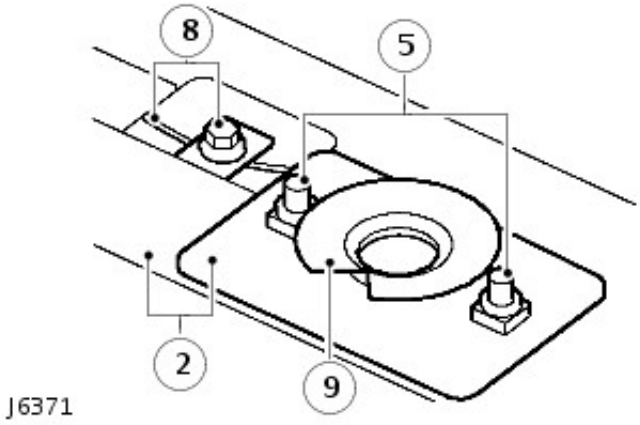
5. Secure plastic sheet.
6. Install door trim casing.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Hood Latch

Removal and Installation

Removal

1. Open hood.
2. Mark position of guide plate and lock to hood platform.
3. Remove 8 screws securing grille.
4. Remove grille.
5. Remove 2 bolts securing guide plate and lock.
6. Remove guide plate.
7. Release spring securing lock to hood platform.
8. Slacken clamping bolt securing hood release cable.
9. Remove lock.



Installation

1. Fit spring between lock and hood platform.
2. Position lock and guide plate to hood platform and nip up bolts.
3. Position guide plate and lock to position marks and tighten bolts to 10 Nm (7 lbf/ft).
4. Fit cable to lock and tighten clamping bolt.
5. Check operation of release cable and adjust if necessary.
6. Fit grille and tighten securing screws.
7. Close hood.

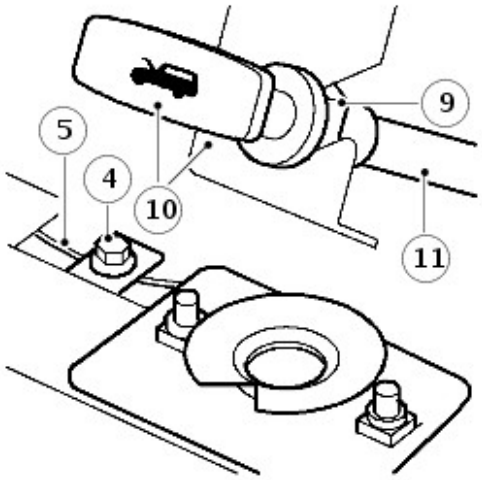
Handles, Locks, Latches and Entry Systems - Hood Latch Release Handle

Removal and Installation

Removal

1. NOTE: Hood release cable renew

   Open hood.
2. Remove 8 screws securing grille.
3. Remove grille.
4. Slacken clamping bolt securing hood release cable.
5. Remove cable from lock.
6. Release cable from clip on underside of hood platform.
7. Feed cable through valance and collect grommet.
8. Release cable from clip fixed to wheelarch under expansion tank.
9. Loosen clamping nut securing hood release handle to mounting bracket.
10. Remove hood release handle from mounting bracket.
11. Withdraw cable through bulkhead.



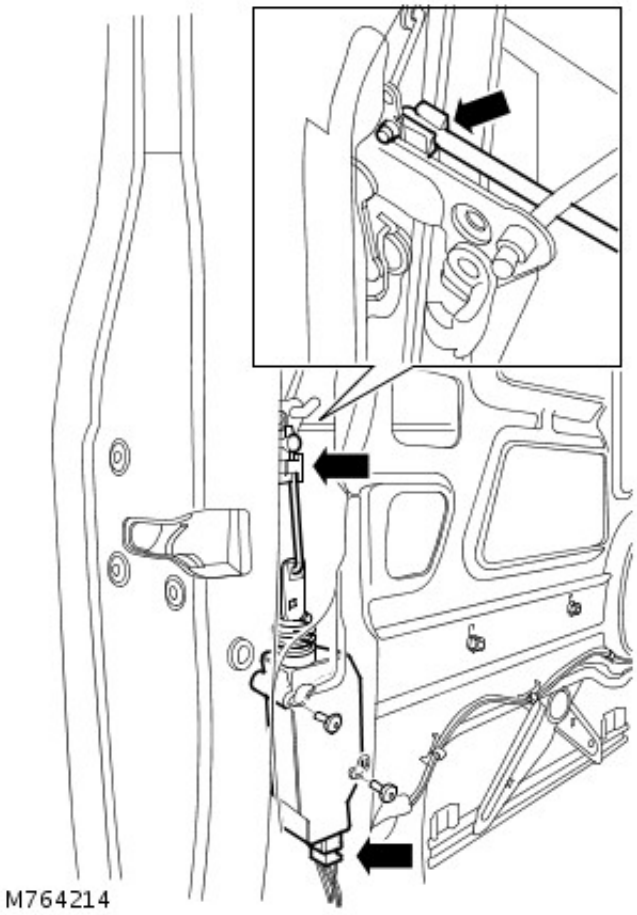
J6372

Installation

1. Feed cable through bulkhead and fit hood release handle to mounting bracket. Tighten clamping nut.
2. Route cable behind expansion tank and fit to securing clip.
3. Feed cable through valance.
4. Fit grommet between cable and valance.
5. Fit cable to securing clip on underside of hood platform.
6. Fit cable to lock and tighten clamping bolt.
7. Check operation of release cable and hood lock and adjust if necessary.
8. Fit grille and tighten screws.
9. Close hood.

Handles, Locks, Latches and Entry Systems - Front Door Lock Actuator
Removal and Installation

Removal



1. Remove door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Carefully peel back plastic sheet to expose mechanism.
3. Release clip, detach and remove lock solenoid link.
4. Loosen 2 screws securing solenoid, release solenoid from mounting panel, disconnect multiplug and remove solenoid.

Installation

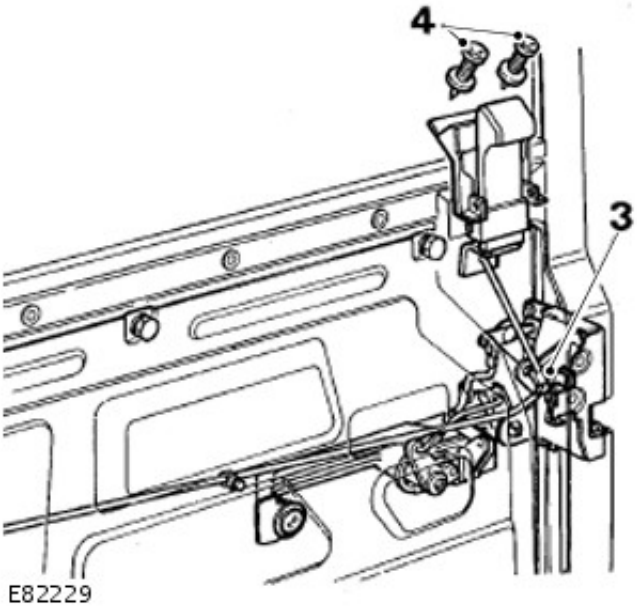
1. Connect multiplug to solenoid, locate solenoid to mounting panel and tighten screws.
2. Instal and secure link.
3. Adjust door latch cable.
   For additional information, refer to: Latch Cable Adjustment (501-14 Handles, Locks, Latches and Entry Systems, General Procedures).
4. |Refit plastic sheet.
5. Fit door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Front Door Push Button Rod and Linkage

Removal and Installation

Removal

1. Remove door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel back sufficient of plastic sheet to expose mechanism.
3. Release spring clip and disconnect operating rod from latch mechanism.
4. Remove 2 screws and withdraw push button rod and linkage.



Installation

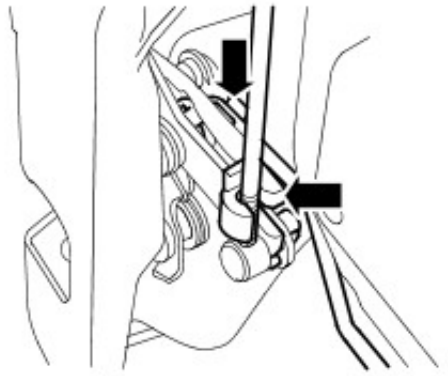
1. Secure push button rod and linkage to door with 2 screws.
2. Connect operating rod to latch mechanism and secure with spring clip.
3. Re-seal plastic sheet and install door trim panel.
   For additional information, refer to: Front Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Rear Door Lock Actuator

Removal and Installation

Removal

1. Remove door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Carefully peel back plastic sheet to expose mechanism
3. Release clip, detach and remove lock solenoid link.
4. Release clip and disconnect interior handle link from latch mechanism.



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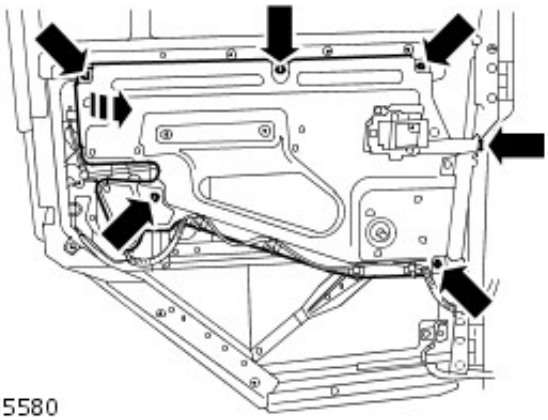
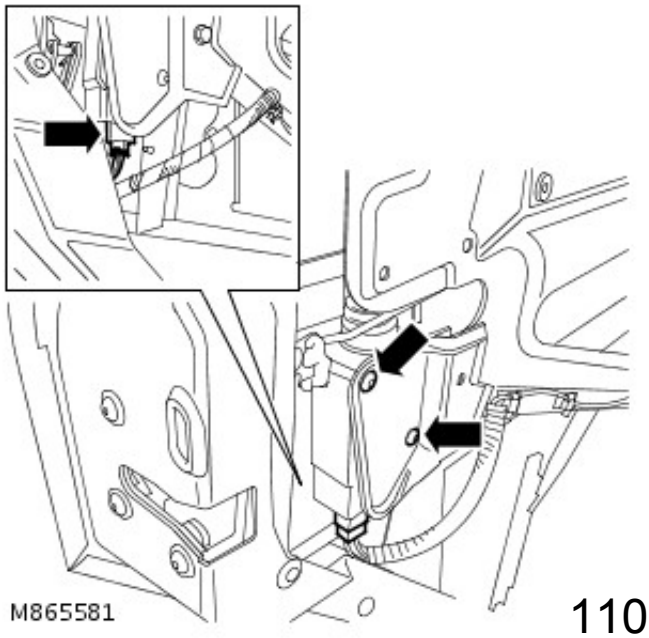
5. Remove 3 bolts securing mounting panel.
6. Loosen remaining bolts and nut, ease mounting panel away from door and retain in this position for access.



M865580

7. Disconnect multiplug from solenoid.
8. Remove 2 screws securing solenoid.



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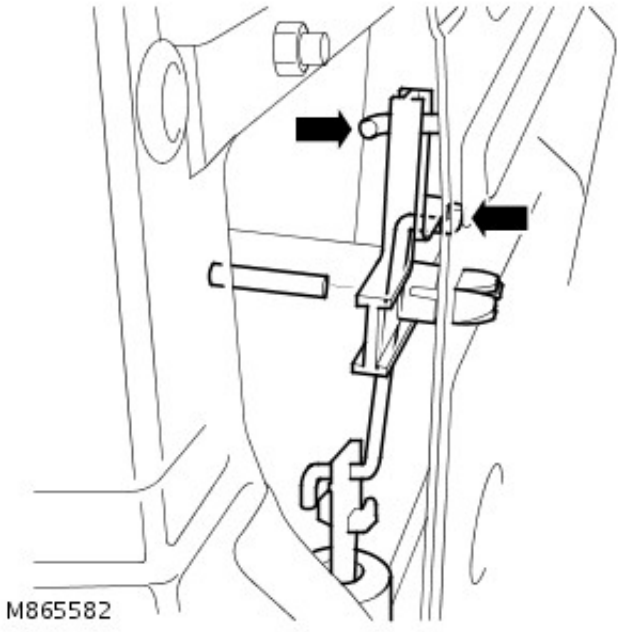


9. Remove centre pin from bellcrank pivot and release pivot from mounting panel.

10. Release bellcrank from sill button link and remove from lock solenoid link.

11. Remove door lock solenoid.

12. Remove link from solenoid.

Installation

1. Install link to solenoid, position solenoid, install bellcrank and connect to sill button link.

2. Secure bellcrank to mounting panel and install centre pin.

3. Align solenoid and install and tighten screws.

4. Connect multiplug to solenoid.

5. Install mounting panel bolts and tighten all bolts and nut to 10 Nm (7 lbf.ft).

6. Connect interior handle link to latch and secure with clip.

7. Install and secure solenoid link.

8. Install plastic sheet.

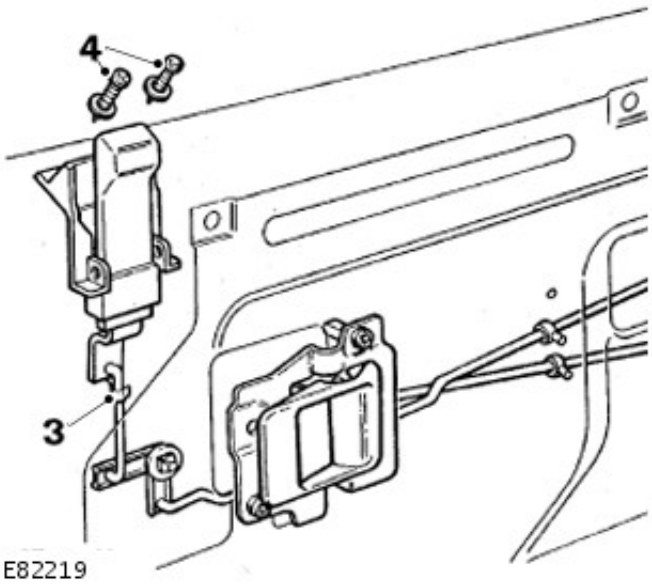
9. Install door trim panel.
For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Handles, Locks, Latches and Entry Systems - Rear Door Push Button Rod and Linkage

Removal and Installation

Removal

1. Remove door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Peel back sufficient of plastic sheet to reveal mechanism.
3. Release spring clip securing button to operating rod and withdraw rod from button.
4. Remove 2 screws securing button to door panel and remove button.



Installation

1. Secure locking button assembly to door panel with 2 screws.
2. Install operating rod to button assembly and secure with spring clip.
3. Re-seal plastic sheet and install door trim panel.
   For additional information, refer to: Rear Door Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

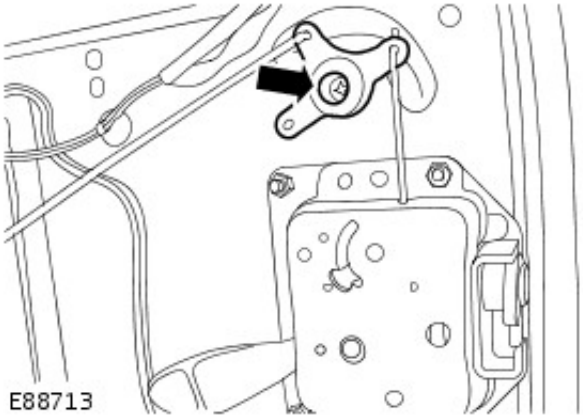
Handles, Locks, Latches and Entry Systems - Taildoor Latch
Removal and Installation

Removal

1. Remove the taildoor trim panel.
For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

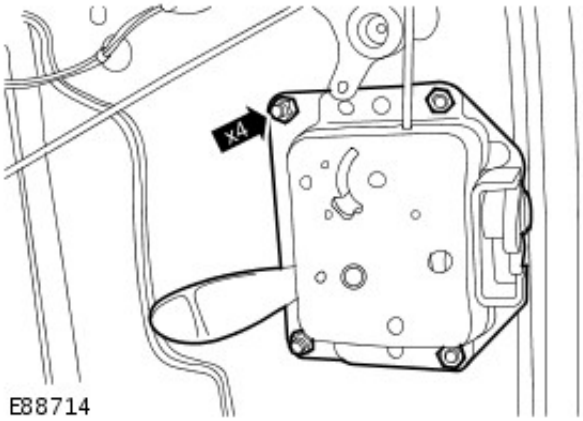
2. Release the central locking control rod pivot.

- Remove the screw.



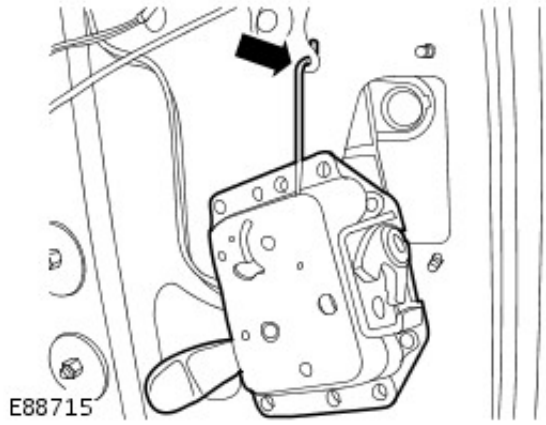
3. Release the taildoor latch.

- Remove the 4 nuts.



4. Remove the taildoor latch.

- Disconnect the taildoor latch from the control rod pivot.

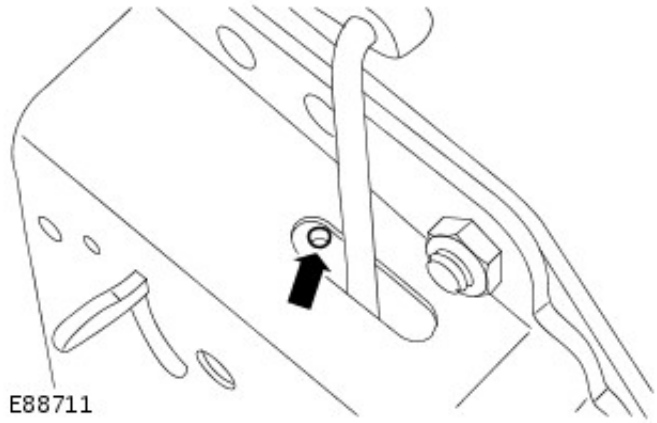


5. NOTE: Do not carry out further dismantling if component is

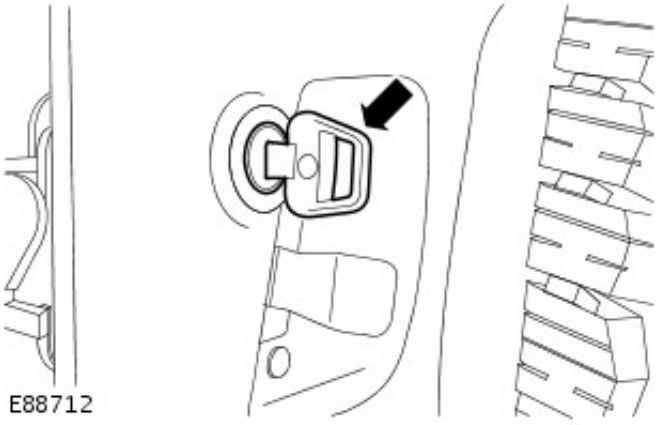
removed for access only.

• NOTE: Make sure the latch is in the locked position.

Using a suitable tool release the lock cylinder.



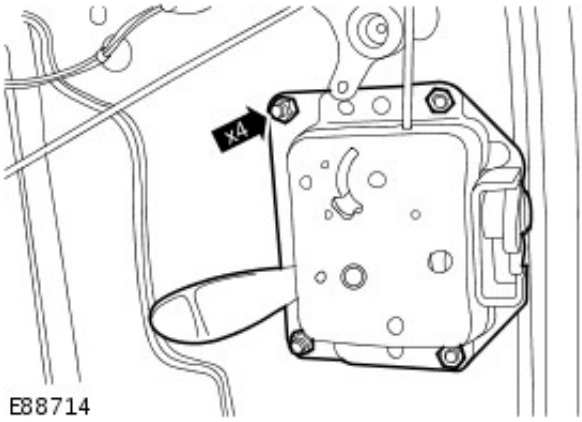
6. Insert the key and remove the lock cylinder.



Installation

1. To install, reverse the removal procedure.

- Tighten to 10 Nm (7 lb.ft).



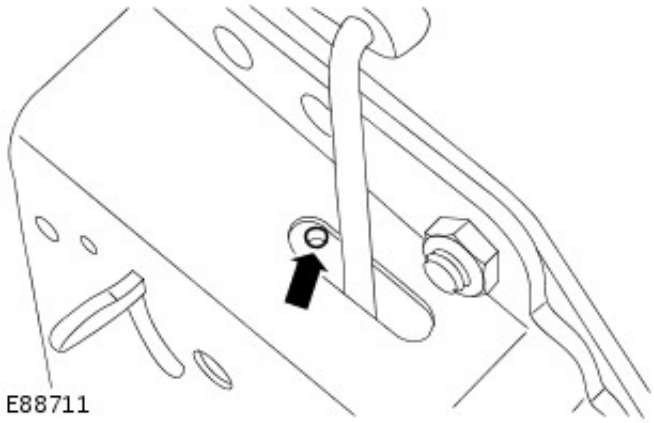
Handles, Locks, Latches and Entry Systems - Taildoor Lock Cylinder

Removal and Installation

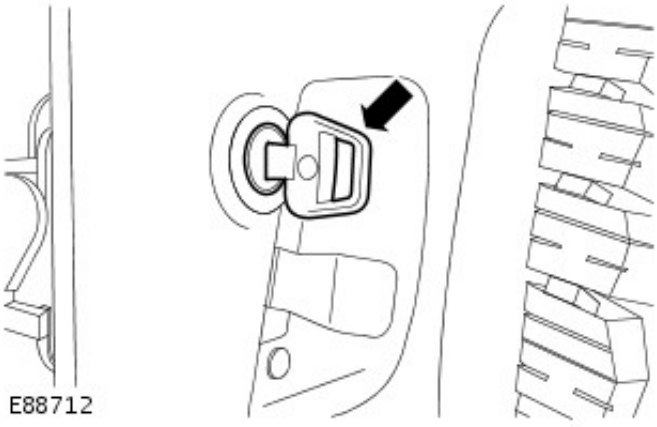
Removal

1. Remove the taildoor trim panel.
   For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. NOTE: Make sure the latch is in the locked position.

   Using a suitable tool release the lock cylinder.



3. Insert the key and remove the lock cylinder.



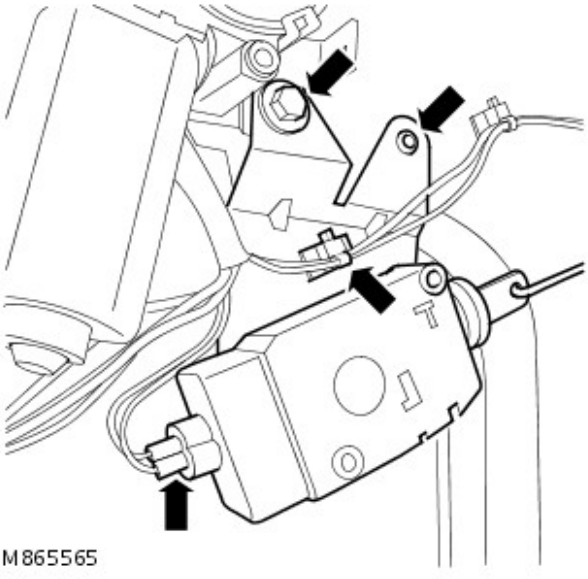
Installation

1. To install, reverse the removal procedure.

Handles, Locks, Latches and Entry Systems - Taildoor Lock Motor
Removal and Installation

Removal

1. Remove tail door trim panel.
   For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect multiplug from taildoor lock motor.
3. Remove bolt and screw securing taildoor lock motor to taildoor.
4. Release clip securing harness to taildoor lock motor mounting bracket.
5. Remove taildoor lock motor assembly from operating rod.



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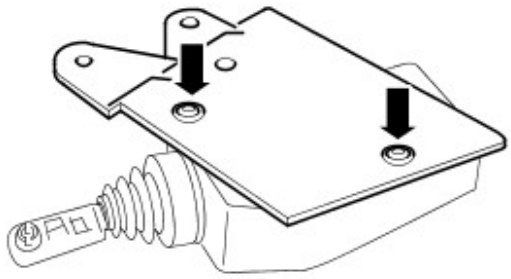
6. Remove 2 screws securing taildoor lock motor to mounting bracket.



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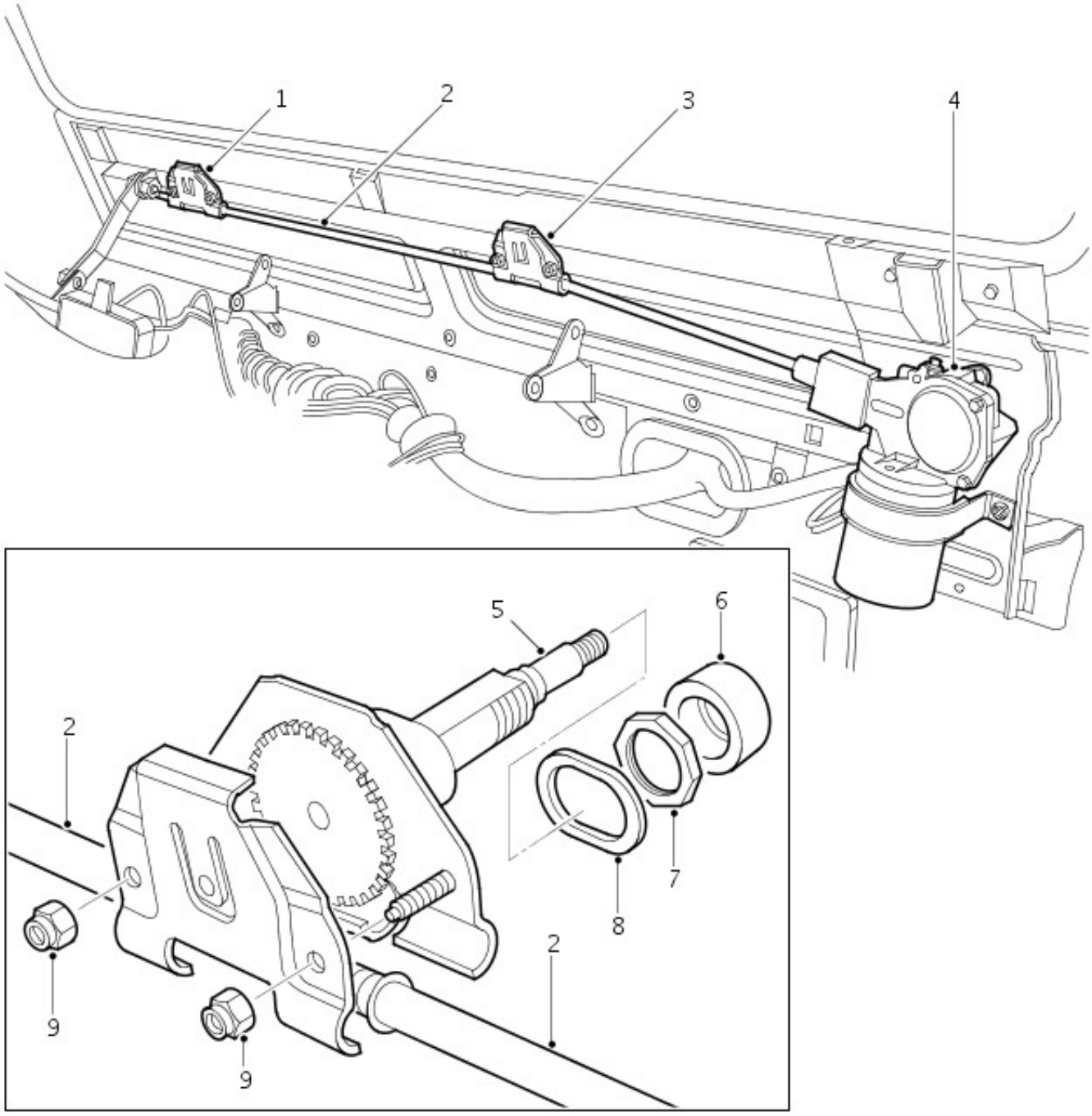
Installation

1. Install taildoor lock motor to mounting bracket and secure with screws.
2. Connect operating rod to taildoor lock motor.
3. Install taildoor lock motor to door, fit screw and tighten bolt to 6 Nm (4 lbf.ft).
4. Position harness to taildoor lock motor mounting bracket and secure with clip.
5. Connect multiplug to taildoor lock motor.
6. Install taildoor trim panel.
   For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

Wipers and Washers - Wipers and Washers

Description and Operation



M840391A

Item	Part Number	Description
1.	-	LH wheelbox
2.	-	Cable
3.	-	RH wheelbox
4.	-	Wiper motor
5.	-	Spindle with DIN taper arm attachment
6.	-	Spacer
7.	-	Locknut
8.	-	Seal
9.	-	Locknuts

WINDSCREEN WIPERS

Although windscreen wiper functionality remains the same, the mechanical architecture has undergone significant changes, for 2002 Model year. The body structure has undergone some minor changes to house the revised wiper linkage.

A modified wiper motor is introduced which is balanced to reduce operation noise. The brush plate is fitted with capacitors to reduce radio interference and a thermal cut-out is introduced to prevent motor burnout. The motor also contains a new park switch which also reduces operation noise. A common motor is now used on both LHD and RHD variants.

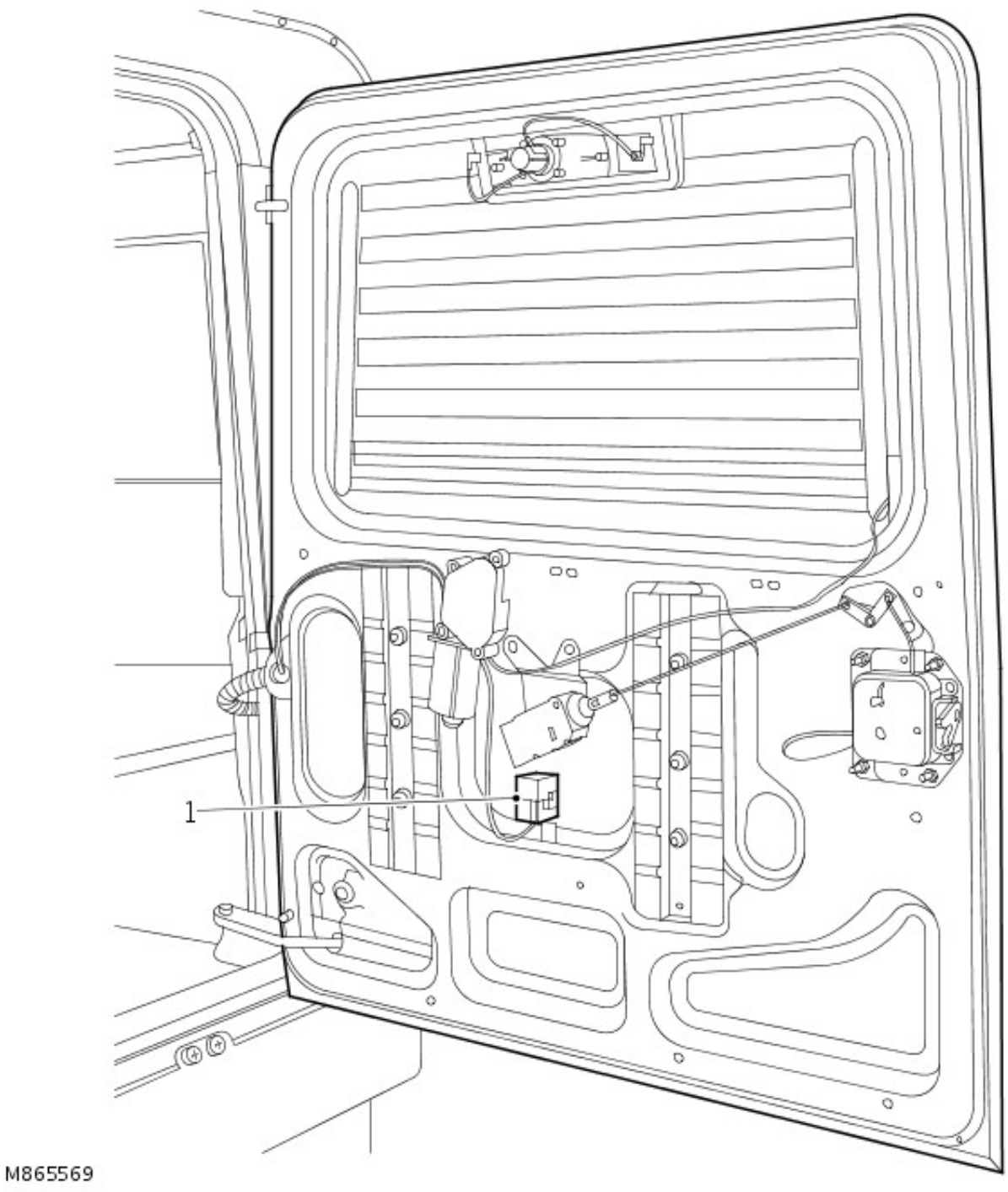
The motor is repositioned on the bulkhead which allows a straighter drive cable run. The straighter run reduces load on the cable allowing a stiffer cable to be used. The stiffer cable and the incorporation of a reduced friction material reduces torsion wind-up of the cable and results in smoother wiper operation and a reduction of blade over travel.

New, larger wheel boxes are fitted in an inverted position from the previous installation. The bulkhead mounting holes are larger with flats for positive location of the wheel box spindle. The wheel boxes now feature a 40 tooth gear ratio in lieu of a 32 tooth gear. This reduces backlash and load and further reduces blade over travel. The wheel box casings are secured with locknuts.

The wheel box spindles now have a splined DIN taper fitting for the new wiper arms which are secured on the spindle with an M8 nut. The taper improves arm retention.

A new grease is introduced which improves wiper operation at very low temperatures.

REAR WIPER



Item	Part Number	Description
1.	-	Rear wiper relay

The rear wiper system is unchanged except for the addition of a wiper motor relay into the electrical circuit, at 2002 model year.

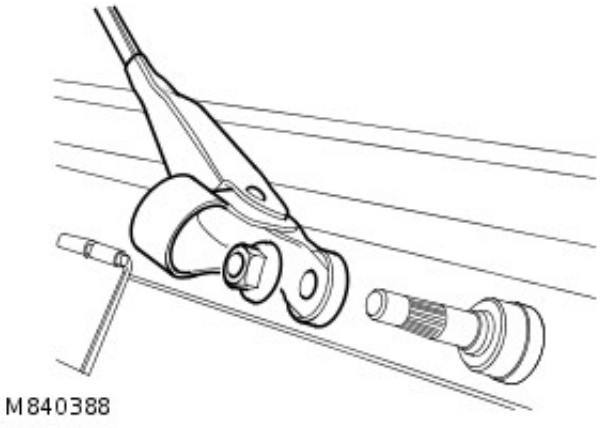
The new rear wiper relay is located in the tail door, below the wiper motor. The relay coil is energised by a feed supplied from the rear wiper switch. When the relay contacts close, a feed is supplied via the ignition switch (position II) and a fuse in the passenger compartment fuse box, through the relay contacts to the wiper motor.

Wipers and Washers - Front Wiper Pivot Arm

Removal and Installation

Removal

1. Raise nut cover on wiper arm and remove nut.



2. NOTE: Do not carry out further dismantling if component is removed for access only.

Remove wiper arm from spindle.

3. Remove wiper blade.

Installation

1. Fit wiper blade.

2. Fit wiper arm to spindle and align blade to windscreen.

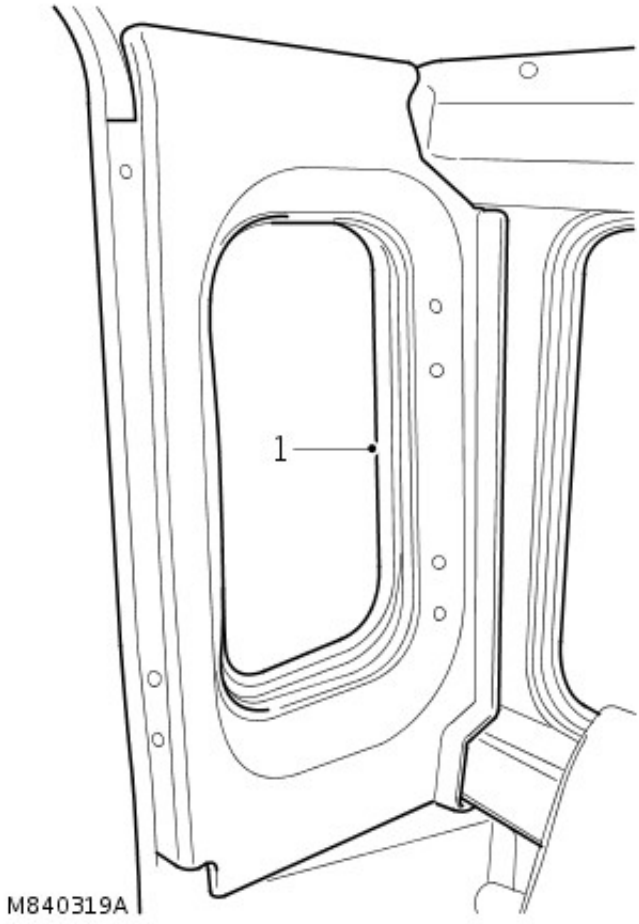
3. Tighten nut securing wiper arm to 17 Nm (13 lbf.ft), and fit cover.

Wipers and Washers - Rear Window Washer Jet

Removal and Installation

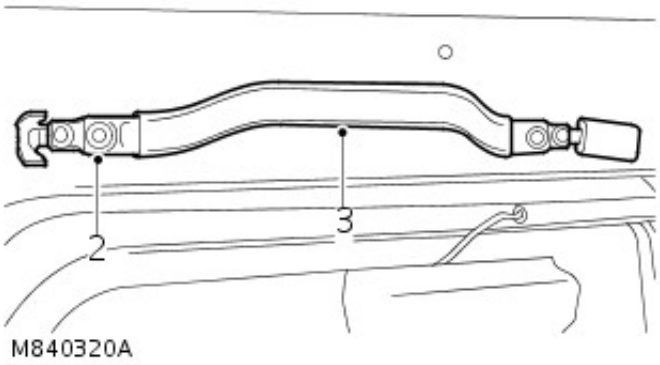
Removal

1. Release and remove both rear side window finishers.

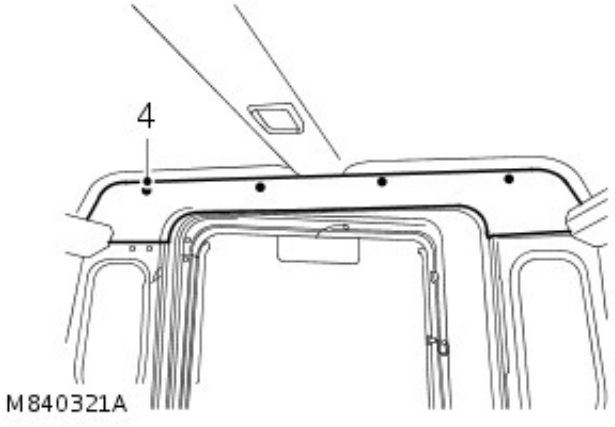


2. Remove 8 screws securing both rear grab handles.

3. Remove both rear grab handles.



4. Remove 4 trim studs securing upper rear finisher to body.



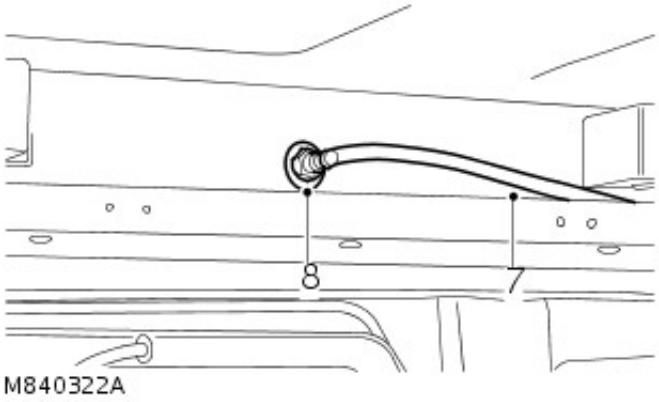
4. Remove 4 trim studs securing upper rear finisher to body.

5. Release and remove upper rear finisher.

6. Position drain tin to collect any fluid spillage.

7. Disconnect washer tube from jet.

8. Remove nut securing washer jet to body.



9. Remove rear window washer jet.

Installation

1. Fit rear window washer jet to body and secure with nut.

2. Connect washer tube to jet.

3. Remove drain tin.

4. Fit upper rear finisher and secure with trim studs.

5. Fit both rear grab handles and secure with screws.

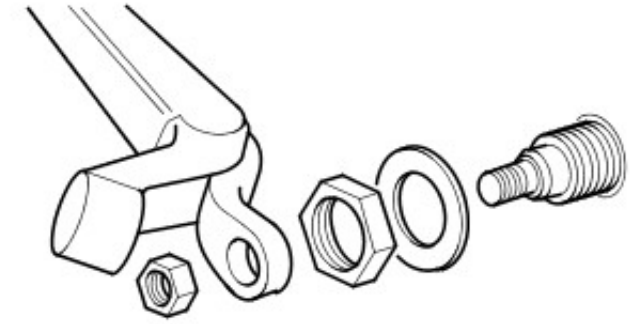
6. Fit both rear side window finishers.

Wipers and Washers - Rear Window Wiper Motor
Removal and Installation

Removal

1. Remove spare wheel from taildoor.

2. Raise nut cover, remove nut and release wiper arm.



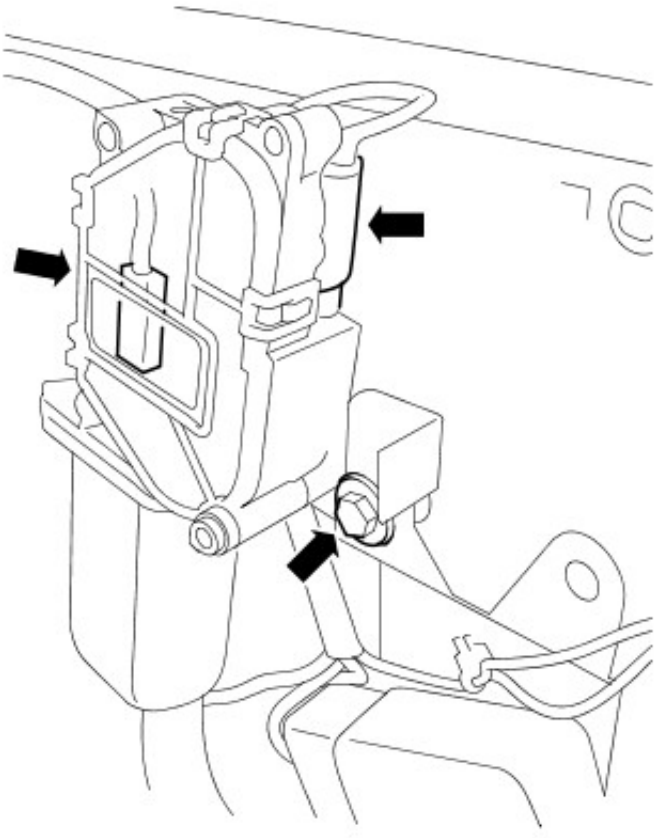
M840392

3. Remove nut and collect washer securing wiper motor to taildoor.

4. Open taildoor.

5. Remove taildoor trim casing.
For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

6. Remove bolt securing door locking solenoid to taildoor.



M840393

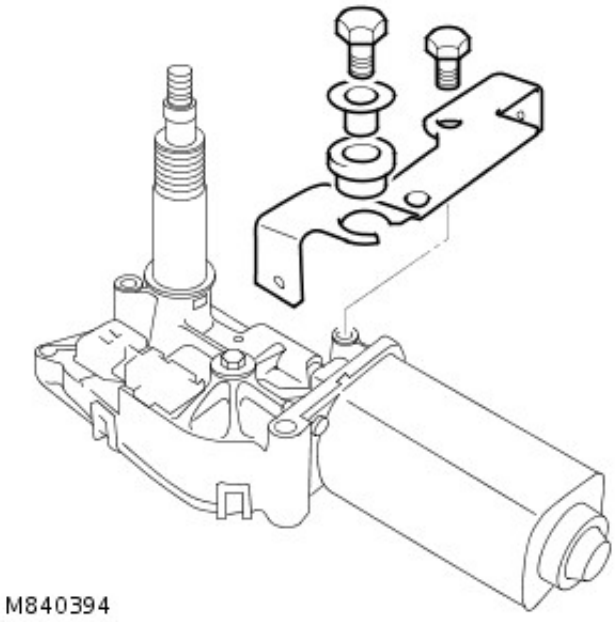
7. Pivot both assemblies and withdraw wiper motor from taildoor.

8. Disconnect multiplugs from wiper motor.

9. NOTE: Do not carry out further dismantling if component is removed for access only.

Remove wiper motor assembly.

10. Remove 2 bolts securing wiper motor to mounting bracket, remove bracket.


M840394

Installation

1. Fit mounting bracket to motor and tighten bolts to 10 Nm (7 lbf.ft).

2. Fit motor spindle to rear door, connect multiplugs and push motor fully home. Align motor mounting bracket with solenoid mounting bracket, fit bolt and tighten to 10 Nm (7 lbf.ft).

3. Fit taildoor trim casing.
For additional information, refer to: Taildoor Trim Panel (501-05 Interior Trim and Ornamentation, Removal and Installation).

4. Fit washer and nut to rear wiper assembly, tighten nut to 3 Nm (2.2 lbf.ft).

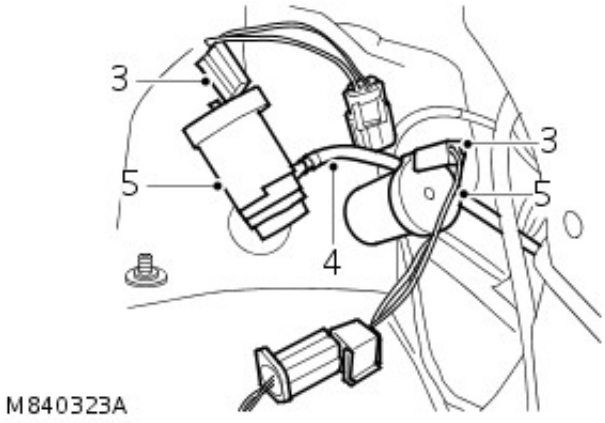
5. Fit wiper arm to spindle, align blade to glass and tighten nut to 17 Nm (13 lbf.ft).

6. Close nut cover.

7. Fit spare wheel and tighten nuts to 45 Nm (33 lbf.ft).

Wipers and Washers - Windshield Washer Pump

Removal and Installation



Removal

1. Remove headlamp.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
2. Position drain tin to collect any fluid spillage.
3. Disconnect multiplug from washer pump.
4. Disconnect hose from washer pump.
5. Release washer pump from reservoir and discard sealing washer.

Installation

1. Fit new sealing washer and secure pump to reservoir.
2. Connect hose and multiplug to washer pump.
3. Fit headlamp.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
4. Fill reservoir with screen cleaning fluid.

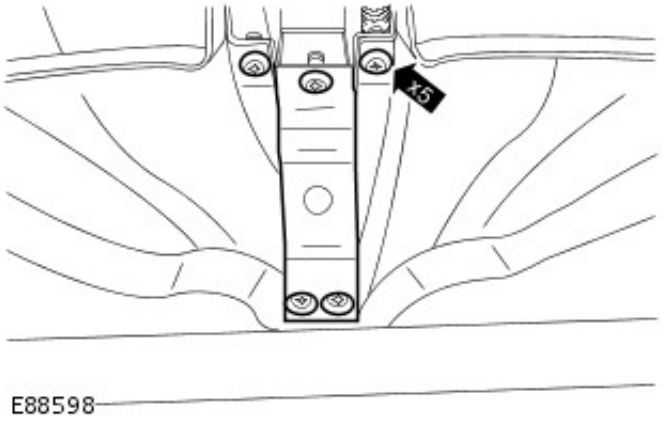
Wipers and Washers - Windshield Wiper Motor
Removal and Installation

Removal

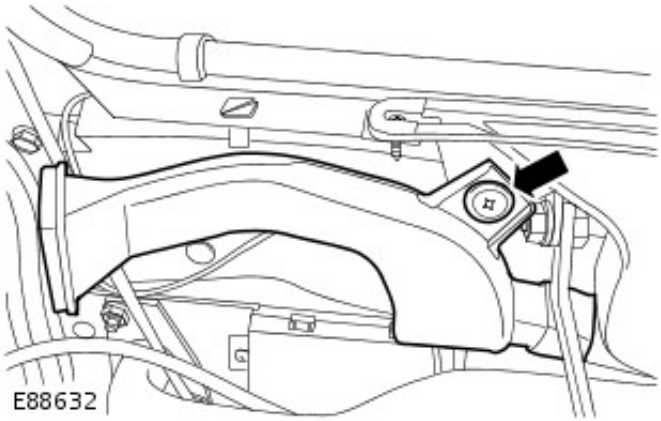
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the instrument panel.
   For additional information, refer to: Instrument Panel (501-12 Instrument Panel and Console, Removal and Installation).
3. NOTE: Make sure the clips are discarded.

   Remove the audio unit support bracket.

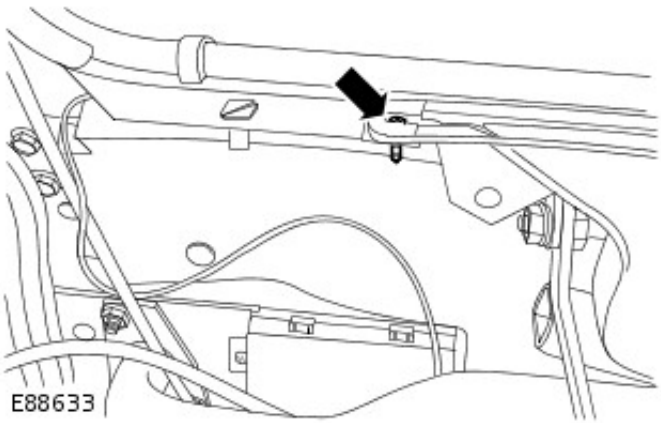
   - Remove and discard the 5 clips.



4. Remove the LH demister duct.
   - Remove the clip.



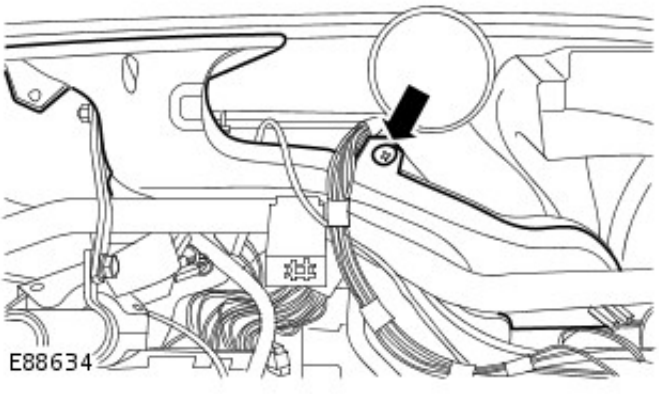
5. Release the LH defrost vent duct.
   - Remove the screw.



6. Remove the LH defrost vent duct.

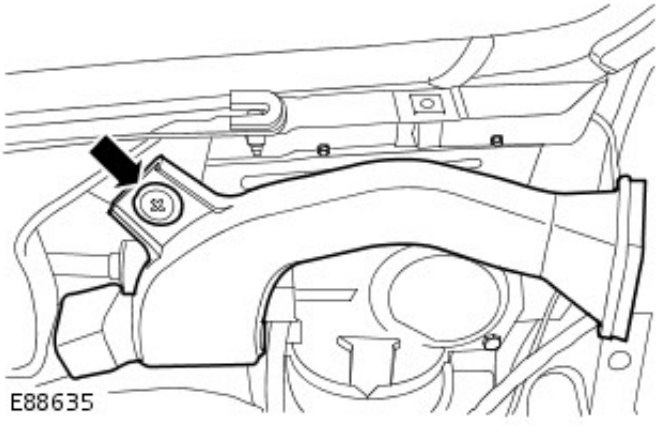
6. Remove the LH defrost vent duct.

- Remove the clip.



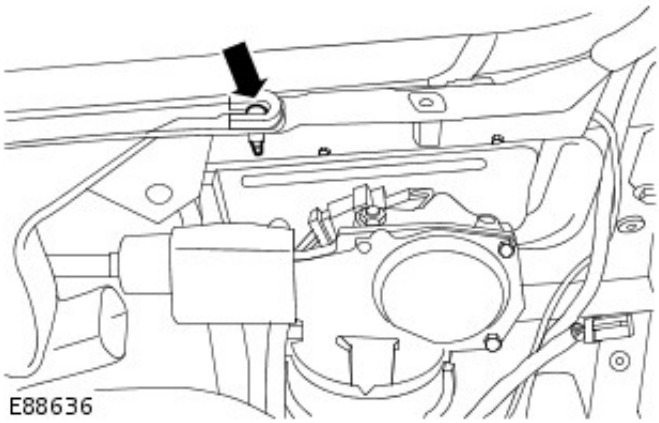
7. Remove the RH demister duct.

- Remove the clip.



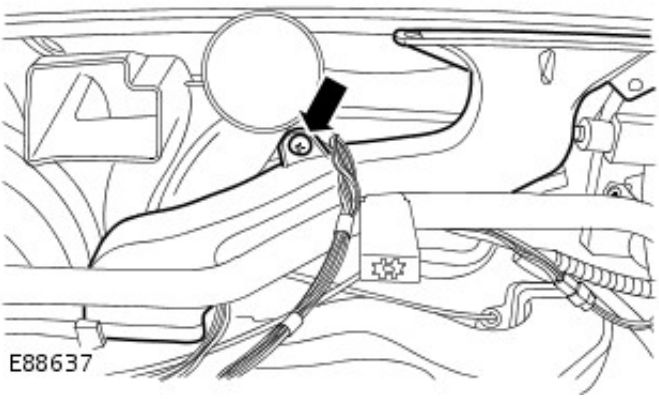
8. Release the RH defrost vent duct.

- Remove the screw.

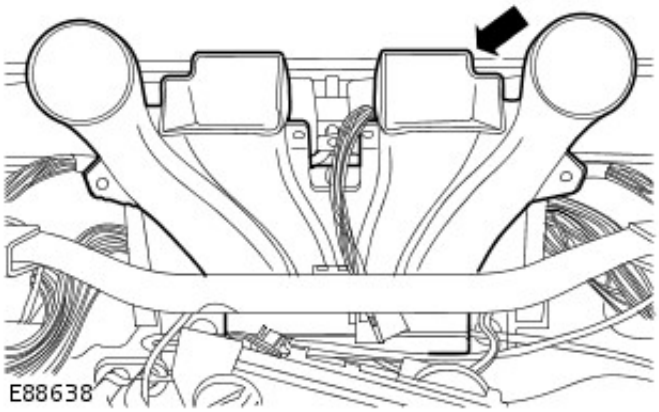


9. Remove the RH vent duct.

- Remove the clip.

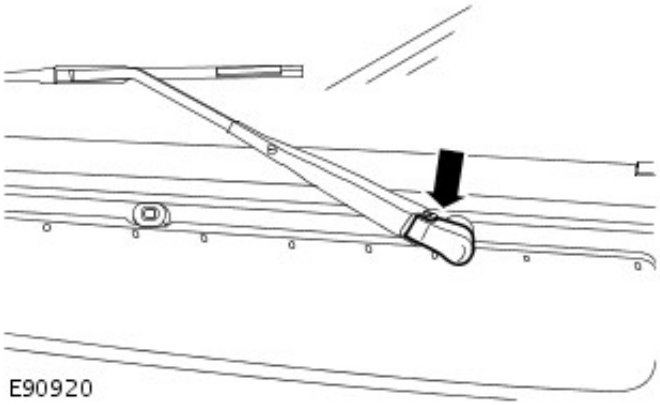


10. Remove the center register duct.



11. NOTE: RH shown, LH similar.

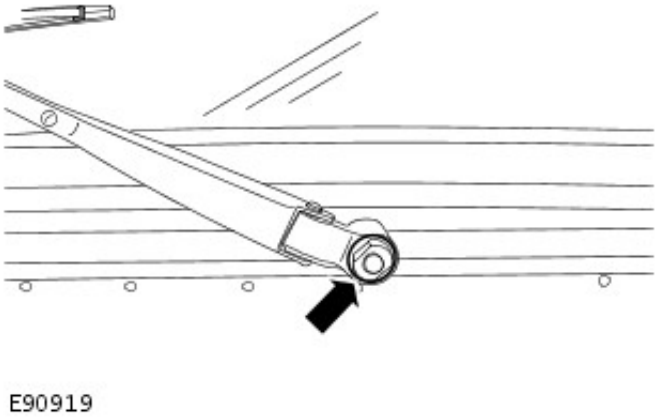
Remove the windshield wiper arm nut cover.



12. NOTE: RH shown, LH similar.

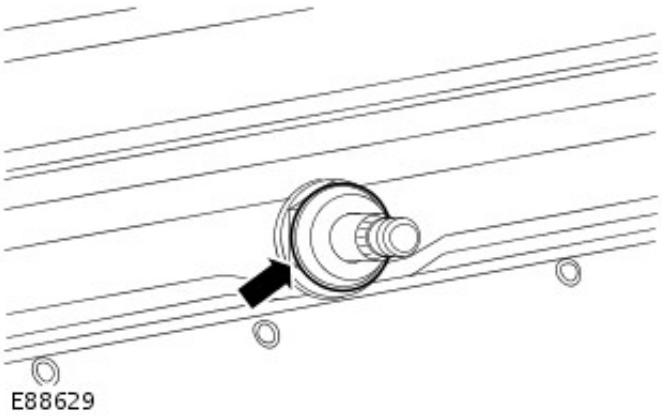
Remove the windshield wiper arm.

- Remove the nut.



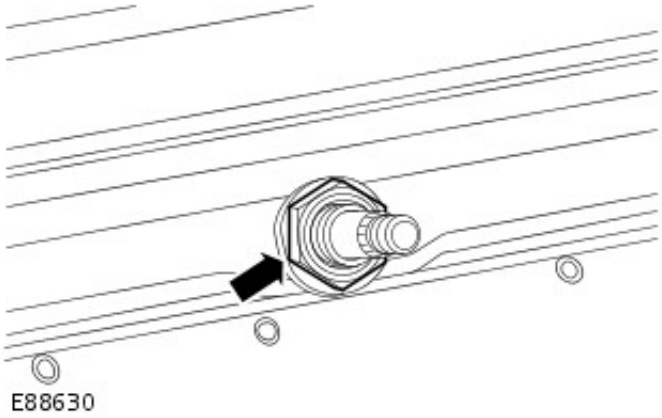
13. NOTE: RH shown, LH similar.

Remove the windshield wiper linkage spindle nut cover.



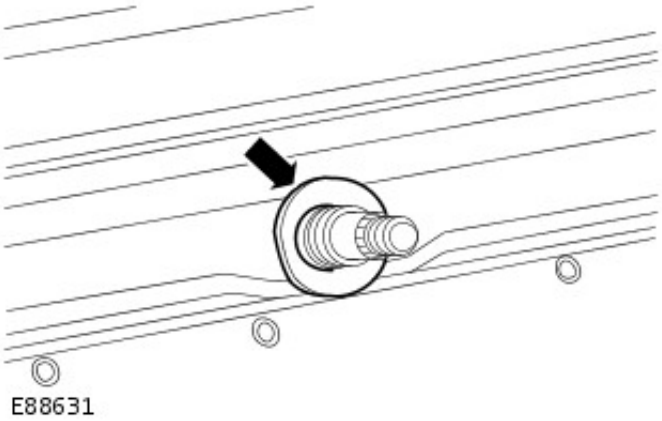
14. NOTE: RH shown, LH similar.

Remove the windshield wiper linkage spindle nut.

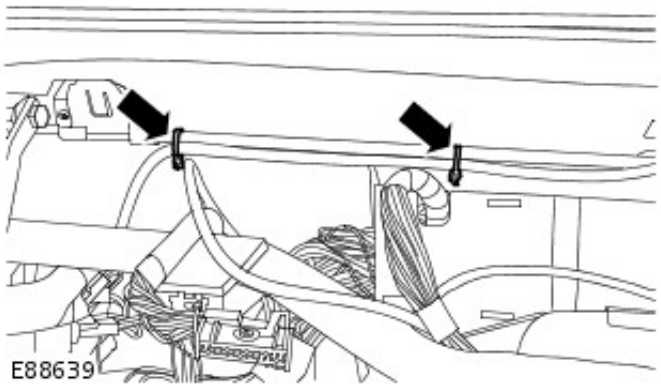

E88630

15. NOTE: RH shown, LH similar.

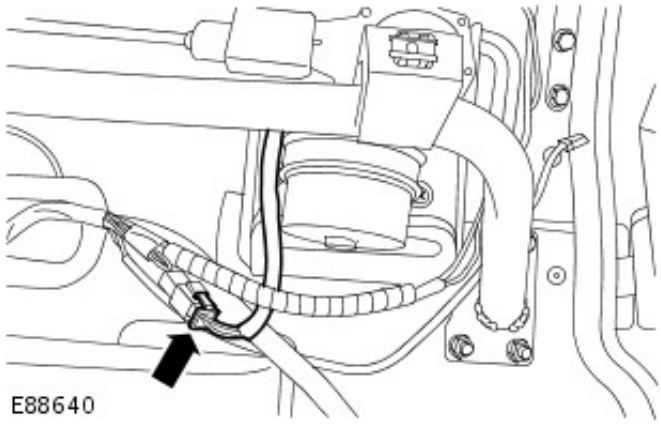
Remove and discard the windshield wiper linkage spindle foam seal.


E88631

16. Remove and discard the 2 tie straps.

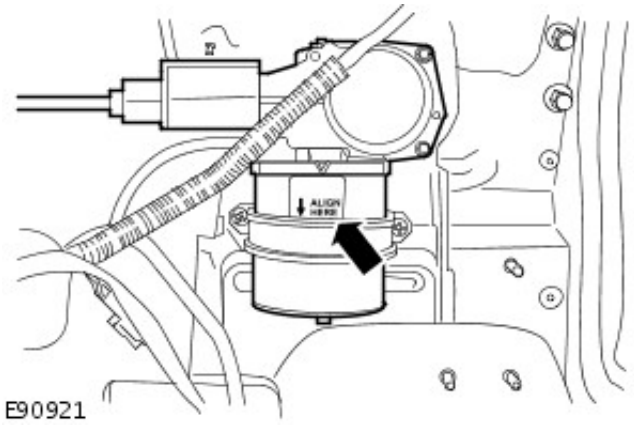

E88639

17. Disconnect the windshield wiper motor electrical connector.


E88640

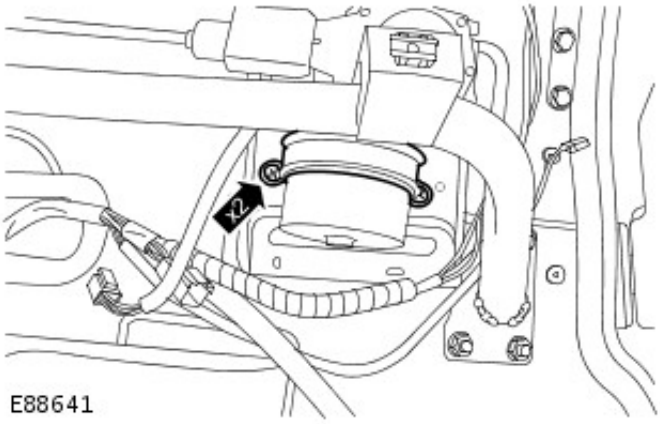
18. Note the fitted position of the component prior to removal.

18. Note the fitted position of the component prior to removal.

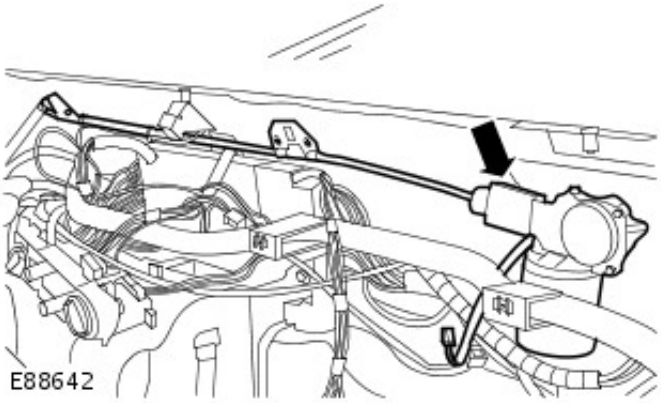


19. Release the windshield wiper motor.

- Remove the 2 screws.



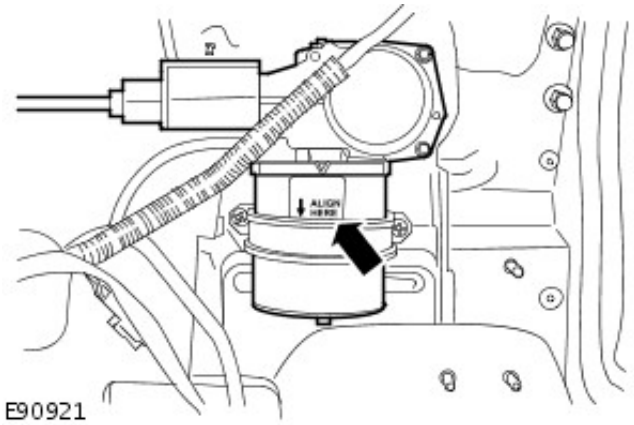
20. Remove the windshield wiper motor.



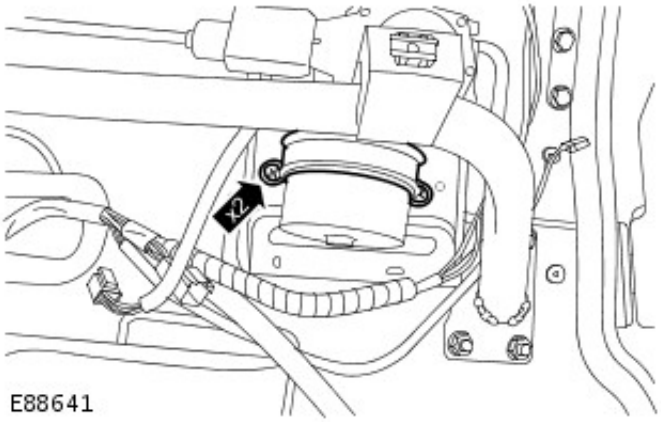
Installation

1. To install, reverse the removal procedure.

2. Install the windshield wiper motor to its original fitted position.



3. Tighten to 5 Nm (4 lb.ft).

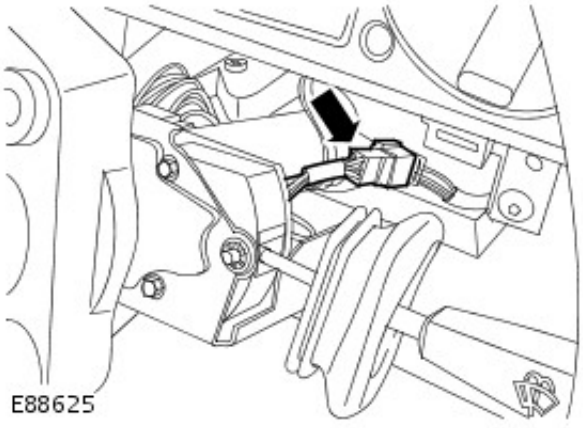


4. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

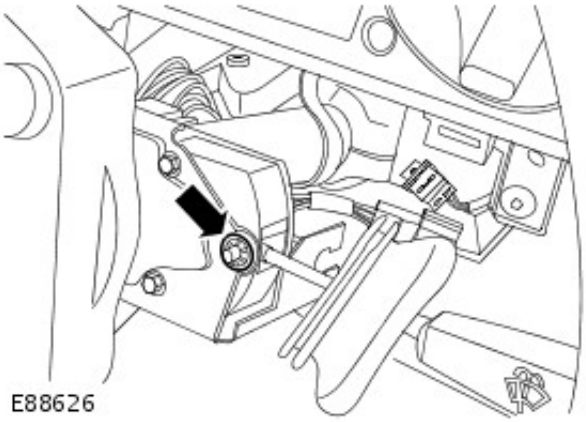
Wipers and Washers - Windshield Wiper/Washer Switch
Removal and Installation

Removal

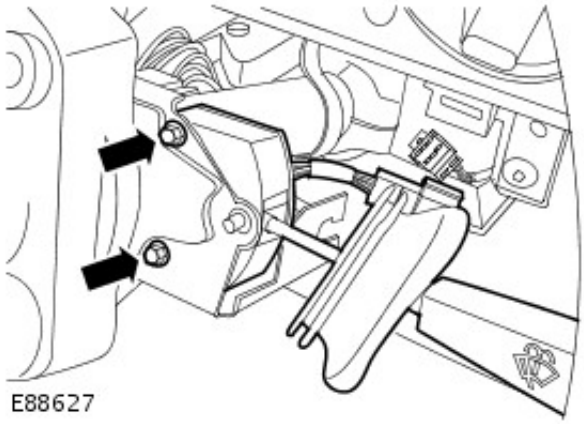
1. Remove the steering column shrouds.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
2. Disconnect the electrical connector.



3. Remove and discard the clip.



4. Remove the windshield wiper switch.
   - Remove the 2 screws.



Installation

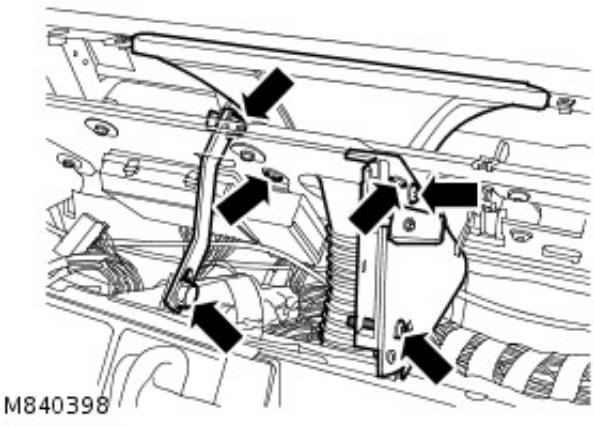
1. To install, reverse the removal procedure.

Wipers and Washers - Wiper Mounting Arm and Pivot Shaft

Removal and Installation

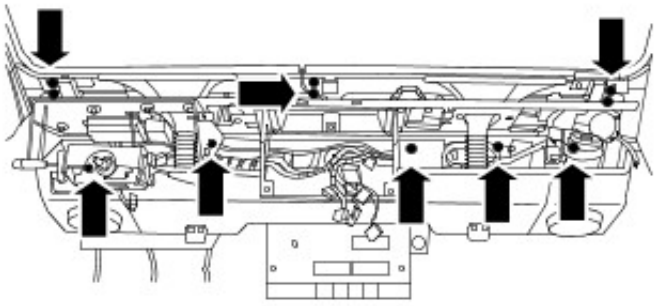
Removal

1. Disconnect battery negative lead.
2. Remove steering column shroud.
   For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
3. Remove windshield wiper motor.
   For additional information, refer to: Windshield Wiper Motor (501-16 Wipers and Washers, Removal and Installation).
4. Remove 2 screws and move heater fan switch aside.



M840398

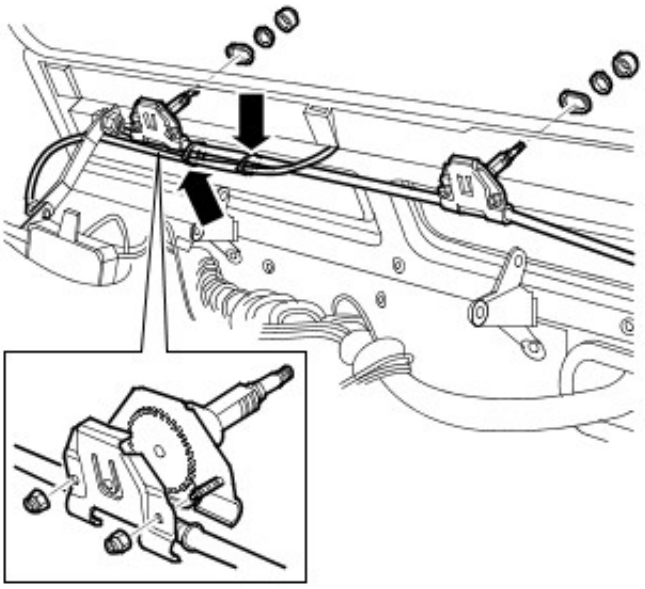
5. Remove 2 screws securing drivers side demister duct.
6. Disconnect demister tube and remove duct.
7. Remove bolt and nut and bolt securing steering column support bracket and remove bracket.
8. Remove 11 screws securing fascia support rail.



M840399

9. Remove cable ties securing washer tube to windshield wiper rack tube.
10. Loosen fully 4 nuts securing backplates to wiper mounting arm and pivot shaft and remove windshield wiper rack tubes.
11. Remove seals from wheel box spindles.
12. Remove 2 nuts securing wiper mounting arm and pivot

shaft and remove sealing washers.



M840400

13. Carefully pull fascia support rail from bulkhead sufficiently to remove wiper mounting arm and pivot shaft.

Installation

1. Loosen fully but do not remove nuts securing wheel box back plates.
2. Grease wiper mounting arm and pivot shaft.
3. Fit wiper mounting arm and pivot shaft, fit sealing washers and tighten nuts to 5 Nm (3.7 lbf.ft).
4. Fit spindle seals.
5. Fit wiper rack tubes and tighten wiper mounting arm and pivot shaft nuts sufficiently to hold tubes. Tighten wheel box back plate nuts to 6 Nm (4 lbf.ft) after fitting windshield wiper motor.
6. Align washer tube to rack tube and secure with cable ties.
7. Align fascia support rail and secure with screws.
8. Fit steering column support bracket and tighten bolt and nut and bolt to 45 Nm (33 lbf.ft).
9. Fit demister duct to tube, align relay bracket and secure duct with screws.
10. Position heater fan switch and secure with screws.
11. Fit windshield wiper motor.
    For additional information, refer to: Windshield Wiper Motor (501-16 Wipers and Washers, Removal and Installation).
12. Fit steering column shroud.
    For additional information, refer to: Steering Column Shrouds (501-05 Interior Trim and Ornamentation, Removal and Installation).
13. Connect battery negative lead.

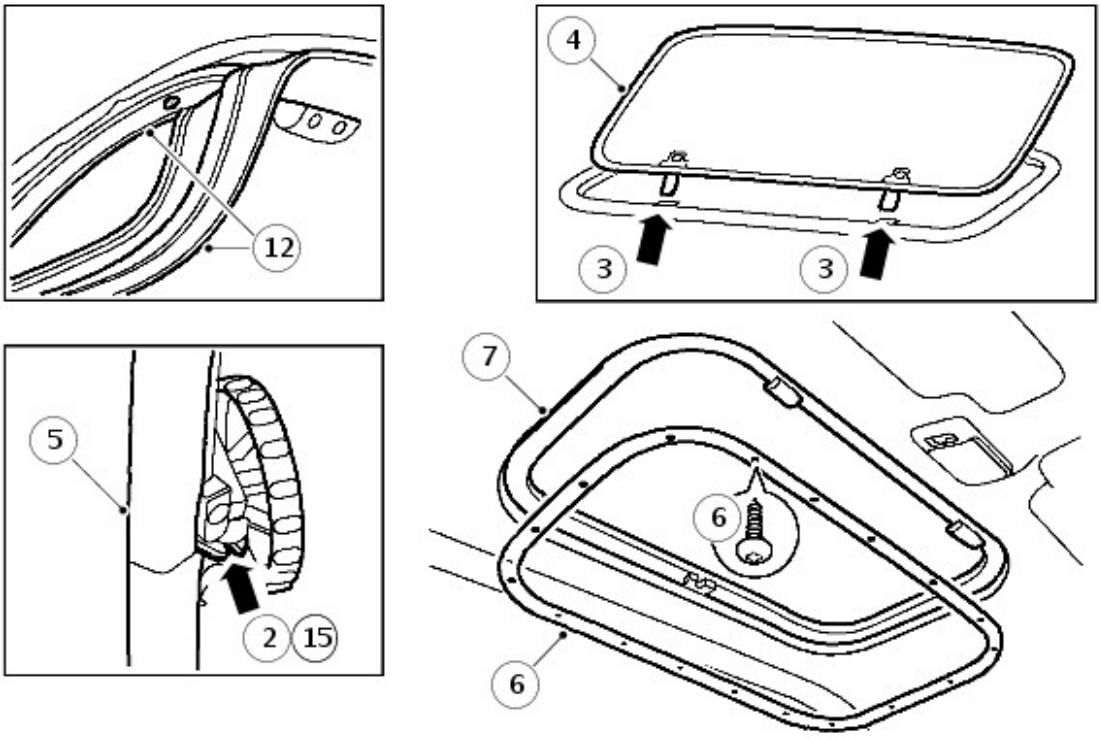
Roof Opening Panel - Roof Opening Panel

Removal and Installation

Removal

1. Open roof opening panel fully.
2. Disengage spring lock from operating handle catch.
3. Holding roof opening panel at both sides, release hinges from locating brackets at front of outer frame.
4. Remove roof opening panel.
5. Starting from centre rear, peel headlining finisher from inner frame.
6. Remove 18 screws securing inner frame to outer frame and detach inner frame.
7. NOTE: Assistance may be required to remove the sun roof assembly.

   Lift outer frame from roof.



J6054

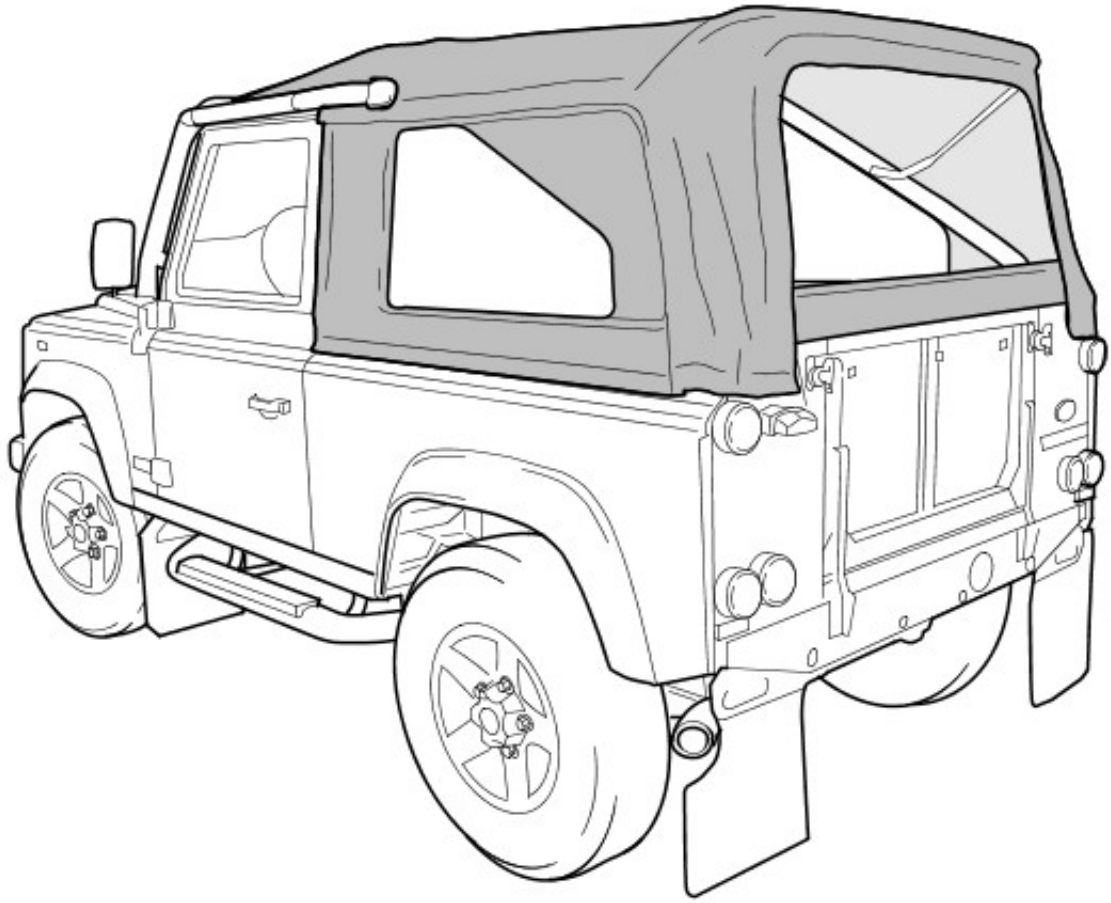
Installation

1. Clean roof area around outer frame seating.
2. Position outer frame on roof.
3. Instal inner frame to headlining and secure to outer frame with 18 screws but do not fully tighten.
4. Check alignment of inner and outer frames with roof mounting and headlining, adjust as necessary, and fully tighten fixing screws to 10 Nm (7 lbf.ft).
5. Starting from centre rear, instal headlining finisher lip into locating channel of inner frame.
6. Press finisher firmly over inner frame and continue around complete frame, ensuring finisher lies flat on headlining.
7. Fit roof opening panel hinges fully into locating brackets on outer frame and lower the glass panel.
8. Engage operating handle catch with spring lock of outer frame and close roof opening panel.

Convertible Top - Convertible Top

Description and Operation

SVX (60th ANNIVERSARY) MODEL - CONVERTIBLE TOP



E101948

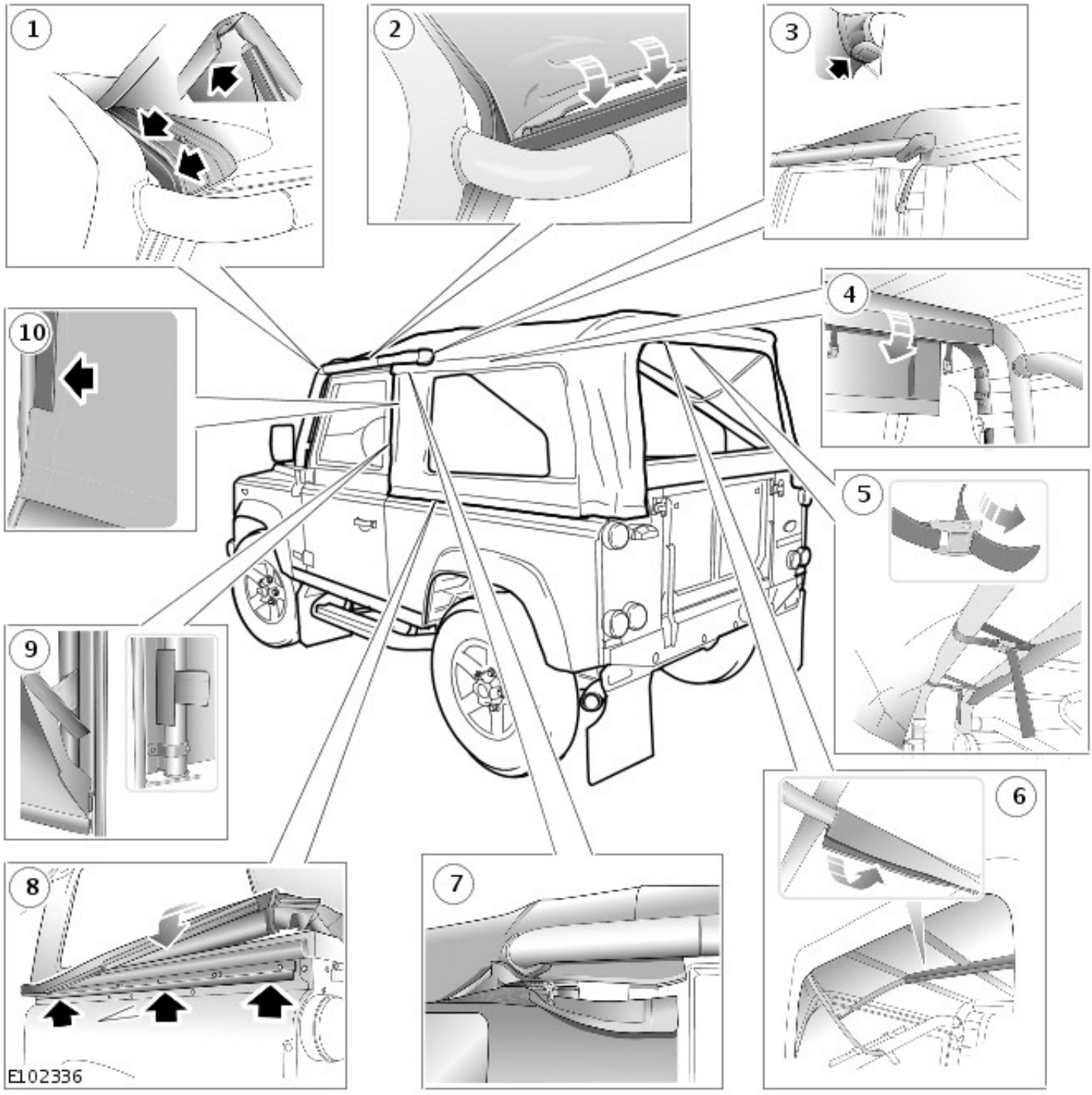
OVERVIEW

The convertible top is new for the SVX 90 model. The top has removable side windows and rear window which are secured with zips.

DESCRIPTION

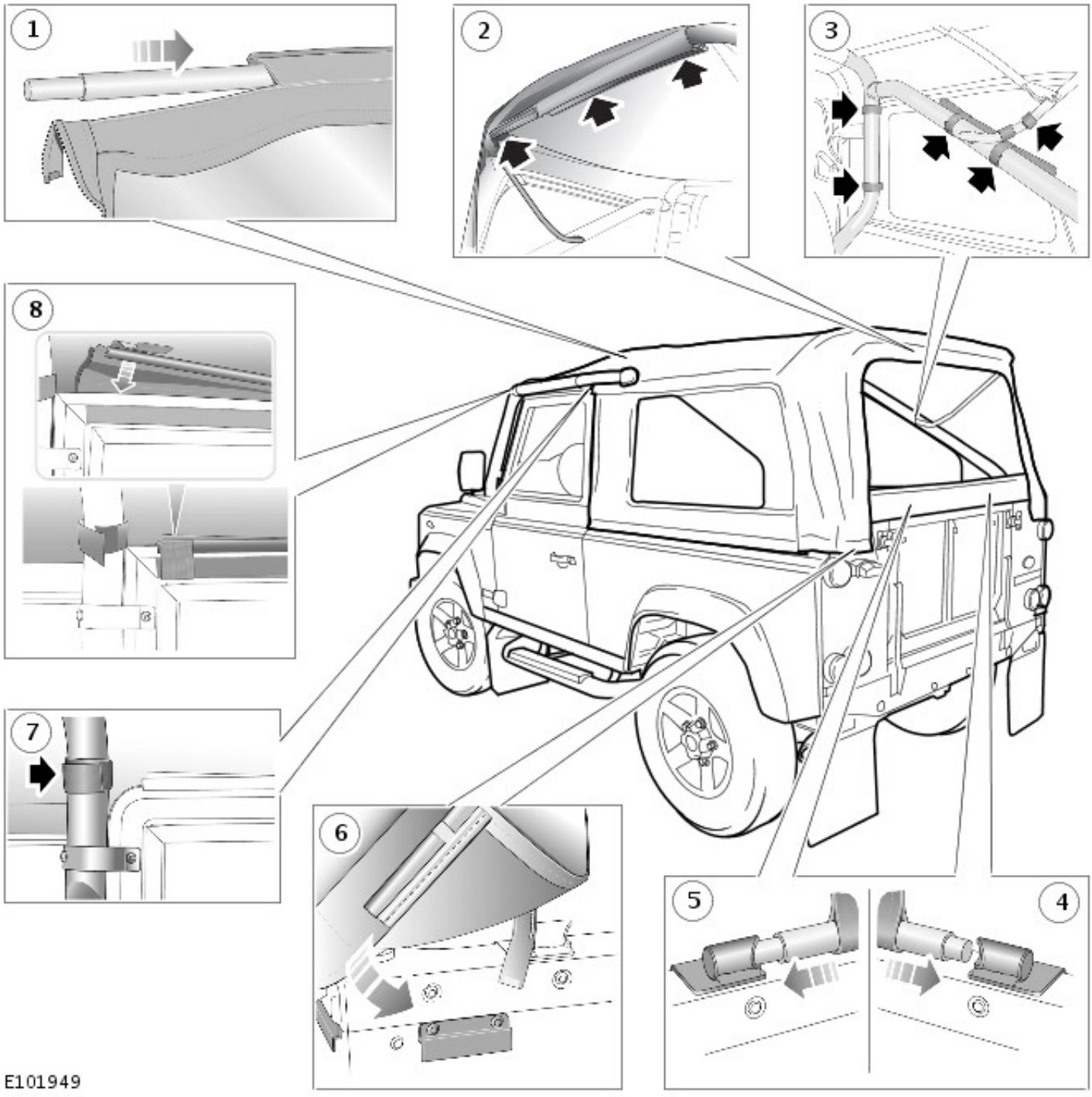
The convertible top is manufactured from canvas panels stitched together, to form a taught, waterproof covering over the cab and load area of the vehicle.

Convertible Top Attachment - Sheet 1



Item	Part Number	Description
1	-	Location of leading edge into locating channel above the windscreen
2	-	Location of outer edges into locating channel above doors
3	-	Velcro strap attachment to support frame where the support frame protrudes from the hood
4	-	Rear part of flap extension pull over support frame
5	-	Three fixing straps located over forward frame bar and tension applied using buckles
6	-	Velcro fixing at rear of convertible top to hinged frame section
7	-	Side window zip attachment
8	-	Attachment to the rail on the body at each side of the load area
9	-	Forward vertical edge of window panel ,elastic strap plate located between frame and vertical body channel
10	-	Plate positioned across gap between frame and vertical body section

Convertible Top Attachment - Sheet 2



Item	Part Number	Description
1	-	Metal spring loaded rod through the bottom edge stitched section of the window panel
2	-	Rear section to rear support frame attachment
3	-	Five velcro fixings on each side of the convertible top to frame and hinged frame
4	-	Metal spring loaded rod location in right-hand (RH) receiver tube
5	-	Metal spring loaded rod location in left-hand (LH) receiver tube
6	-	Rear corner section location in rail on rear body
7	-	Velcro strap to support frame above safety belt anchor point
8	-	Location into interior locating channel in rail above door door and velcro strap location to door frame

It is recommended that fitting and removal of the convertible top is performed by two people.

The rear pivoting support frame is secured with a velcro strap which must removed to allow the frame to be extended to its support position.

The leading edge of the top is located in channels at the top of the windshield. Channels above each door also provide location for the outer edge of the top and once installed are secured in position with further location in an inner channel. Velcro straps near to the seat belt upper anchor point secure the top to the support frame. Three additional velcro straps secure the top onto the door frame.

The convertible top at the rear of the cab area is secured with two flaps which are attached with velcro. From inside the vehicle, the rearmost of the two flaps is wrapped around the support frame. Tension for the top is provided by three straps. The center strap is pulled over the forward frame bar and pulled through the buckle to tension the top. This process is repeated with the two outer straps which provide tension evenly over the top. The rear most flap is wrapped around the support frame, concealing the straps. The forward flap is also wrapped around the support frame in the opposite direction and the velcro attached to the rearmost flap, secures the flaps together.

On the outside of the convertible top, velcro straps are used to secure the top to the support frame where it protrudes from the top.

The top is secured at the rear with a flap which locates on the hinged section of the rear support frame and secured with velcro.

The handed side windows are zipped into position in the top. The top is attached to the rail on the body at each side of the load area. The top is pulled down tightly to locate in the rail which applies tension to the top.

An elastic strap with a bridge plate attached, is positioned from the outside of the vehicle, through a gap between the support frame and the vehicle body. The plate is positioned across the support frame and the vehicle body to secure and the elastic strap maintains the tension on the front vertical edge of the side window and ensures they are located tightly into the body channel.

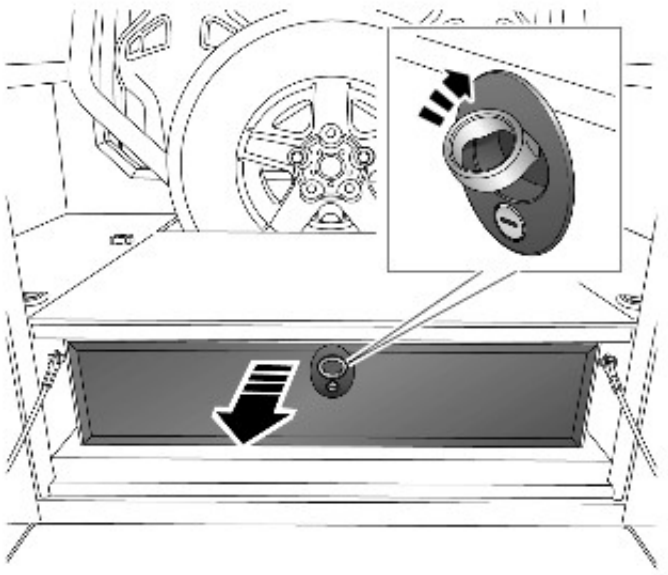
At the rear of the vehicle, each corner of the top is attached to small rails on either side of the tail gate. The top is pulled down tightly which applies tension to the top.

Five velcro straps are located on each side of the convertible top and secure the top to the support frame and the hinged frame.

A metal spring loaded rod locates through a slot in the lower part of the rear window which is zipped in position. The spring loaded rod locates in 2 receiver tubes attached to the top edge of the tail gate.

Removal is a reversal of the fitting process.

Stowage Locker



E101950

When the convertible top is removed, it can be carefully folded and stored in the locker in the rear of the load area. The locker has a hinged lid which can be locked for security using the vehicle key.

Ensure the convertible top and window panels are dry before folding and storing in the locker.

Convertible Top Care Points

Do not use an automatic car wash. Doing so will cause damage to the hood.

Some high pressure cleaning systems are sufficiently powerful to damage hood fabrics. Never aim a high pressure water jet at zips or seals.

If the hood is stained, it should be cleaned within 24 hours of the incident occurring, otherwise the stain may become permanent.

Never use spirit, petrol or chlorine based cleaning agents, or wash/wax compounds to clean the hood and windows - wax polishes will become ingrained in the textured finish.

Use a soft brush to remove dust and flaking dirt from the hood (not the windows), then soak with a mild soap and water solution to soften encrusted dirt and remove stains, prior to washing.

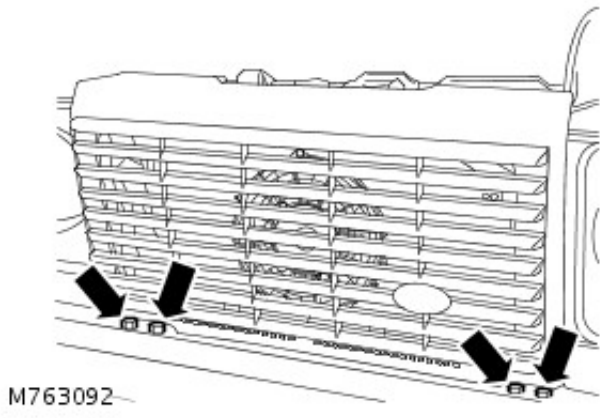
Wash using a mild soap and water solution, before rinsing the hood with clean lukewarm or cold water. Rinse until all traces of soap are removed.

Ensure the hood is dry before folding or removing

Improper cleaning and lack of care may cause damage to the hood and window panels, resulting in water penetration.

Bumpers - Front Bumper

Removal and Installation



Removal

1. Remove 6 screws and remove front grille.
2. Remove 4 through bolts securing front bumper to chassis longitudinals.
3. Remove front bumper.

Installation

1. Instal front bumper to chassis longitudinals and secure with bolts.
2. Instal front grille and secure with screws.

Safety Belt System -

Torque Specifications

Description	Nm	lb-ft
Front safety belt retractor bolt	31	23
Front safety belt upper anchor bolt	31	17
Front safety belt lower anchor bolts	10	7
+ Front safety belt buckle M10 bolt	22	16
Front safety belt buckle M8 bolt	22	16
Rear safety belt retractor bolt	31	17
Rear safety belt upper anchor bolt	31	17
Rear safety belt lower anchor bolt	31	17
Rear center safety belt retractor bolt	31	17
Rear safety belt buckle bolt	31	17
Third row safety belt retractor bolt	31	17
Third row safety belt upper anchor bolt	31	17
Third row safety belt lower anchor bolt	31	17
Third row safety belt buckle bolt	31	17

Safety Belt System - Safety Belt System

Description and Operation

COMPONENT LOCATION

E85612

OVERVIEW

A three point safety belt is installed at each seat position. All the safety belts have Emergency Locking Retractors (ELR).

ELR retractors incorporate a liftshaft locking system with webbing sensor and car sensor activating mechanisms. The webbing sensor activates the locking system if the webbing is subjected to a sharp pull. The car sensor activates the locking system if the vehicle is subjected to sudden deceleration or a severe tilt angle.

FRONT SAFETY BELTS

The retractor of each front safety belt is attached to the related B pillar. The webbing runs from the retractor through an upper mounting, attached to the B pillar, to an anchor point on the front seat.

The buckle for each front safety belt is to the vehicle body inside of the related front seat frame.

SECOND ROW SAFETY BELTS

The retractor of each outboard second row safety belt is attached to the body immediately behind the D pillar. The webbing runs from the retractor, through an upper mounting on the D pillar, to an anchor point at the front of the related wheel arch.

The retractor for the center second row safety belt is installed in the top of the seat back. The webbing runs from the retractor, over the top of the seat, to an anchor point at the base of the seat frame.

The buckles for the second row safety belts are attached to the related seat frame.

THIRD ROW SAFETY BELTS (110 only)

The retractor of each third row safety belt is attached to the E pillar. The webbing runs from the retractor, through a mounting on the E pillar to an anchor point on the floor. The buckles for the third row safety belts are attached to the related seat frame.

BELTMINDER (GULF MARKETS ONLY)

The belt minder function provides warnings to the driver if the appropriate front safety belts are not fastened when driving. The belt minder function is controlled by the instrument cluster
For additional information, refer to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation).
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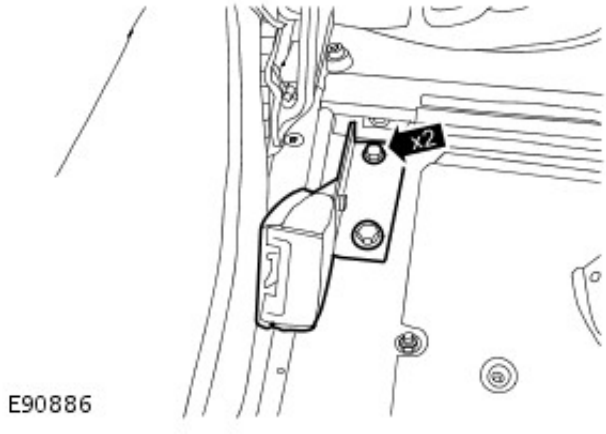
Safety Belt System - Front Safety Belt Buckle

Removal and Installation

Removal



1. Remove the front safety belt buckle.

- Remove the M8 bolt.
- Remove and discard the M10 bolt.

Installation

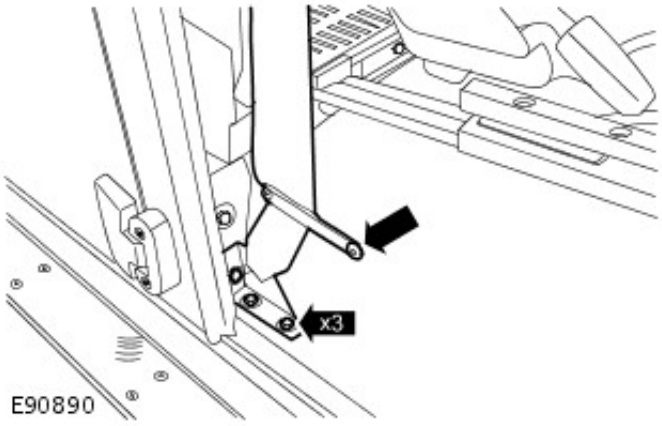
1. Install the front safety belt buckle.

- Tighten the new M10 bolt to 23 Nm (17 lb.ft).
- Tighten the M8 bolt to 23 Nm (17 lb.ft).

Safety Belt System - Front Safety Belt Retractor

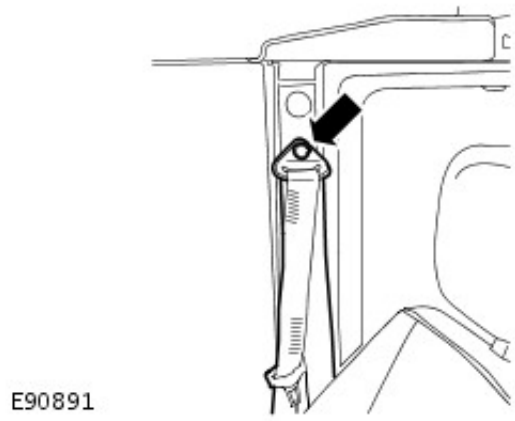
Removal and Installation

Removal



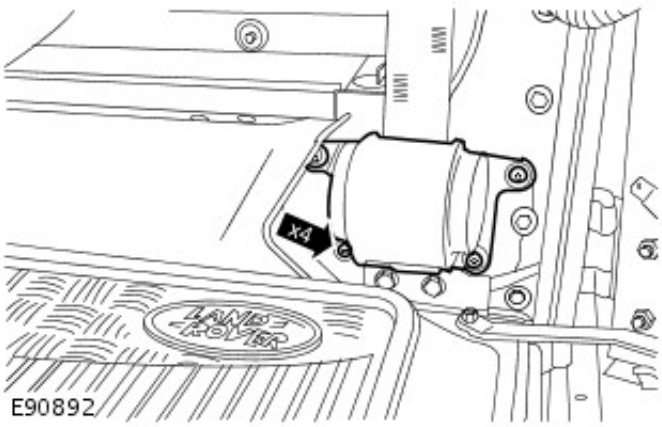
1. Release the front safety belt lower anchor.

- Remove the 3 bolts.
- Remove the clip.



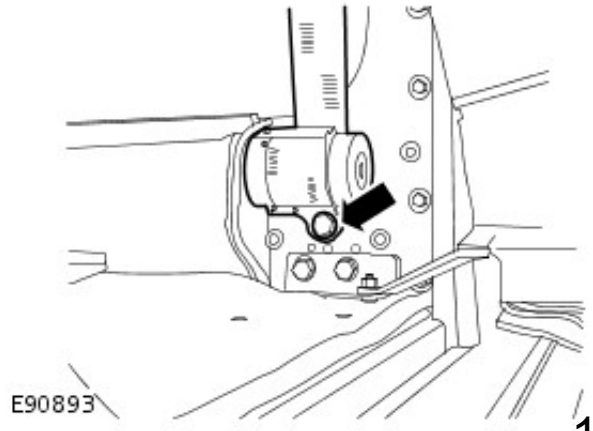
2. Release the front safety belt upper anchor.

- Remove the bolt cover.
- Remove the bolt.



3. Remove the front safety belt retractor trim.

- Remove the 4 scrivets.



4. Remove the front safety belt retractor.

- Remove the bolt.

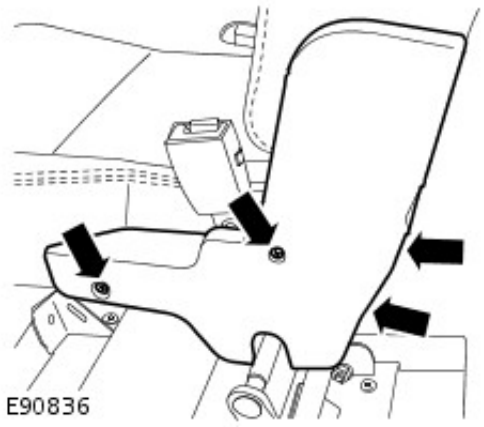
Installation

1. Install the front safety belt retractor.
   - Tighten the bolt to 31 Nm (23 lb.ft).
2. Install the front safety belt retractor trim.
   - Install the scrivets.
3. Secure the front safety belt upper anchor.
   - Tighten the bolt to 31 Nm (23 lb.ft).
   - Install the bolt cover.
4. Secure the front safety belt lower anchor.
   - Tighten the bolts to 10 Nm (7 lb.ft).
   - Install the clip.

Safety Belt System - Rear Center Safety Belt Buckle

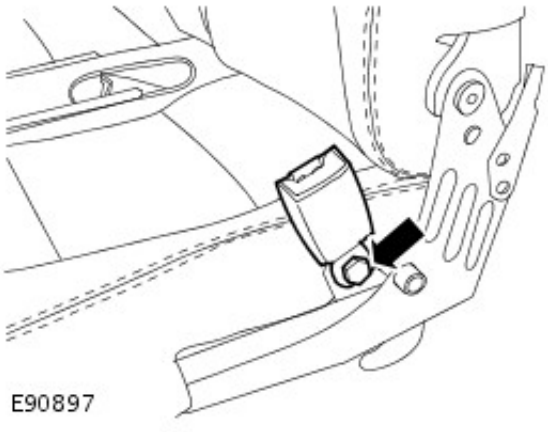
Removal and Installation

Removal



1. Remove the RH rear seat inner hinge trim panel.

- Remove the 4 screws.



2. Remove the rear center safety belt buckle.

- Remove the bolt.

Installation

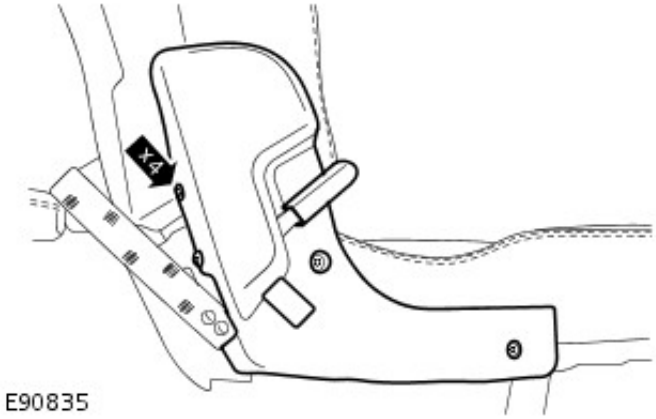
1. To install, reverse the removal procedure.

- Tighten the bolt to 31 Nm (23 lb.ft)

Safety Belt System - Rear Center Safety Belt Retractor

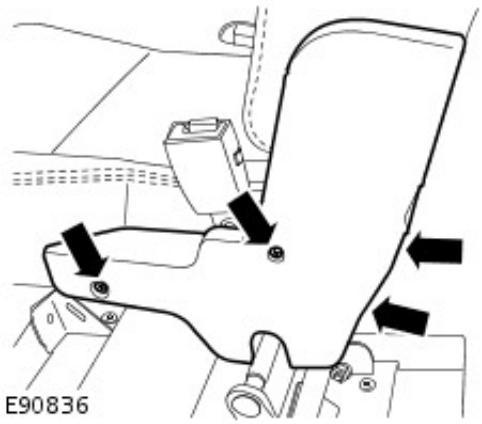
Removal and Installation

Removal



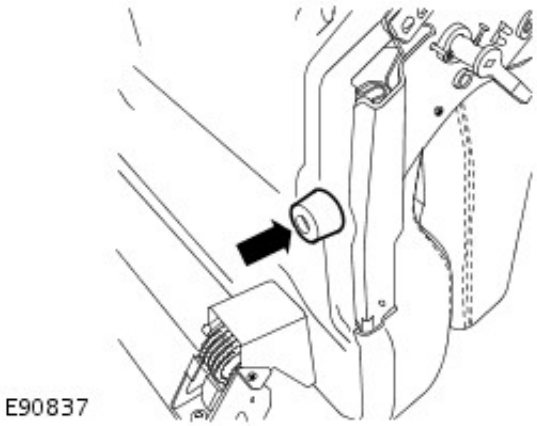
1. Remove the rear seat outer hinge trim panel.

- Remove the rear seat recliner handle.
- Remove the 4 screws.



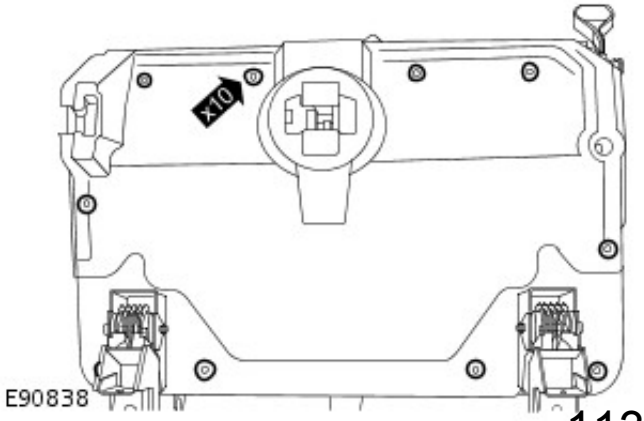
2. Remove the rear seat inner hinge trim panel.

- Remove the 4 screws.



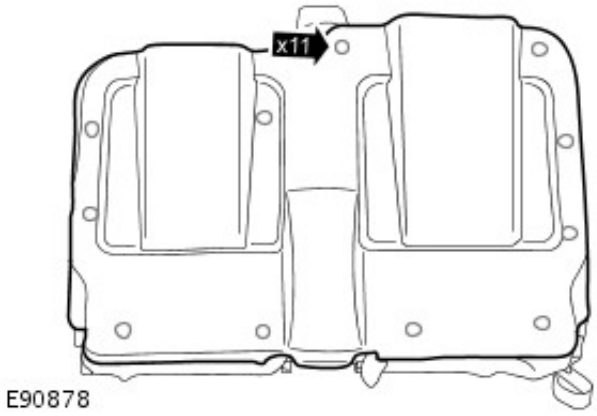
3. Remove the rear seat base stop.

- Remove the bolt.
- Collect the plastic washer.



4. Remove the rear seat cushion trim panel.

- Remove the 10 clips.

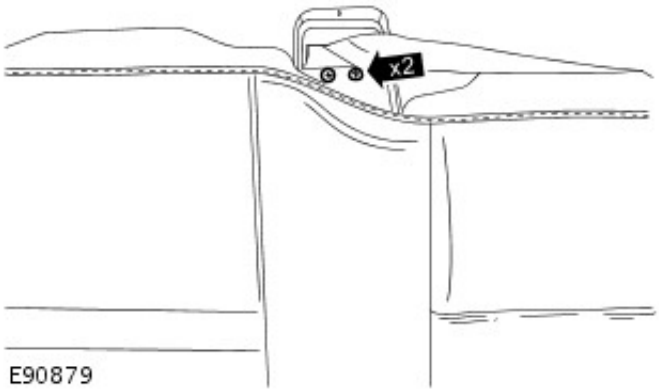


E90878

5. Remove the rear seat backrest trim panel.

- Release the 11 clips.

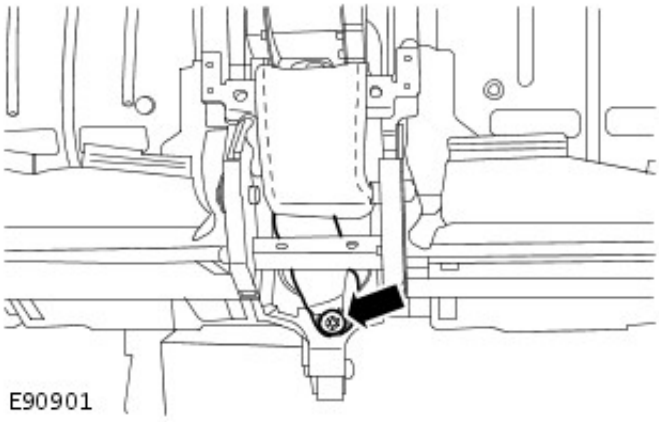
6. Reposition the rear center safety belt guide cover.



E90879

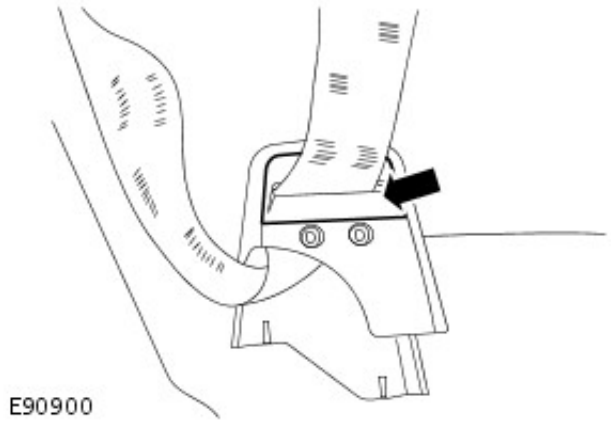
- Remove the 2 screws.

7. Release the rear center safety belt lower anchor.


E90901

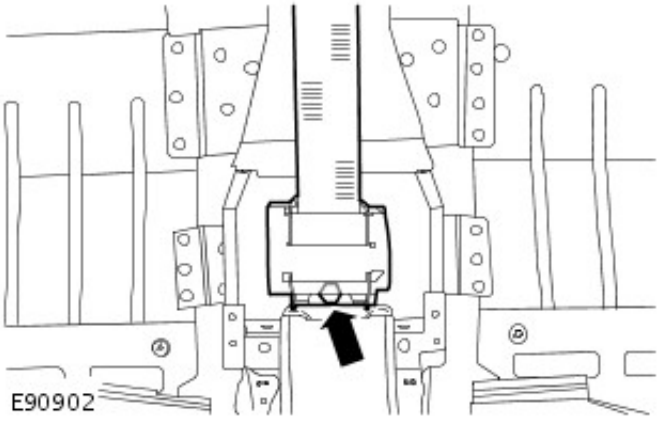
- Remove the bolt.

8. Remove the rear center safety belt guide cover.


E90900

- Remove the rear center safety belt guide cover finisher.

9. Remove the center rear safety belt retractor.



- Remove the bolt.

Installation

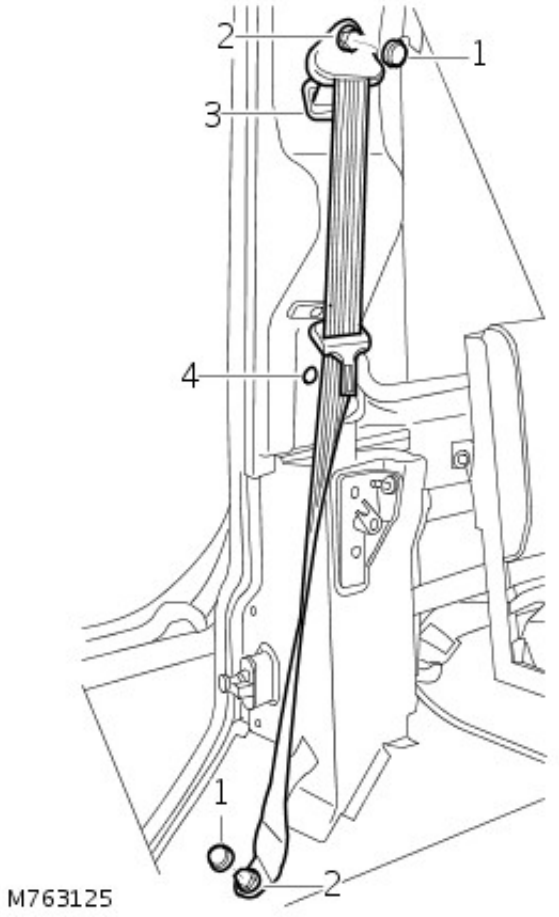
1. Install the center rear safety belt retractor.
   - Tighten the bolt to 31 Nm (23 lb.ft).
2. Install the rear center safety belt guide cover.
   - Install the rear center safety belt guide cover finisher.
3. Secure the rear center safety belt lower anchor.
   - Tighten the bolt to 31 Nm (23 lb.ft).
4. Secure the rear center safety belt guide cover.
   - Tighten the screws.
5. Install the rear seat backrest trim panel.
   - Secure with the clips.
6. Install the rear seat cushion trim panel.
   - Install the clips.
7. Install the rear seat base stop.
   - Install the plastic washer.
   - Tighten the bolt to 23 Nm (17 lb.ft).
8. Install the rear seat inner hinge trim panel.
   - Tighten the screws.
9. Install the rear seat outer hinge trim panel.
   - Tighten the screws.
   - Install the rear seat recliner handle.

Safety Belt System - Rear Safety Belt Retractor

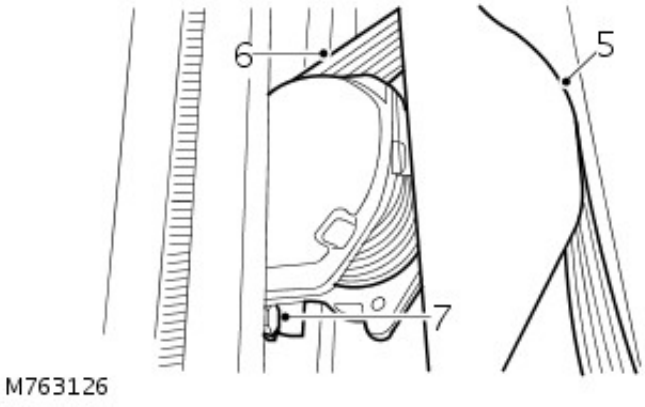
Removal and Installation

Removal

1. Remove cap from seat belt guide bolt.
2. Remove seat belt upper and lower securing bolts.
3. Remove seat belt guide from D-pillar finisher.
4. Remove 2 studs securing finisher to D-pillar.



5. Release finisher from body upper rail and D-pillar.
6. Pull seat belt through D-pillar finisher.
7. Remove bolt securing seat belt to D-pillar and remove belt assembly.



Installation

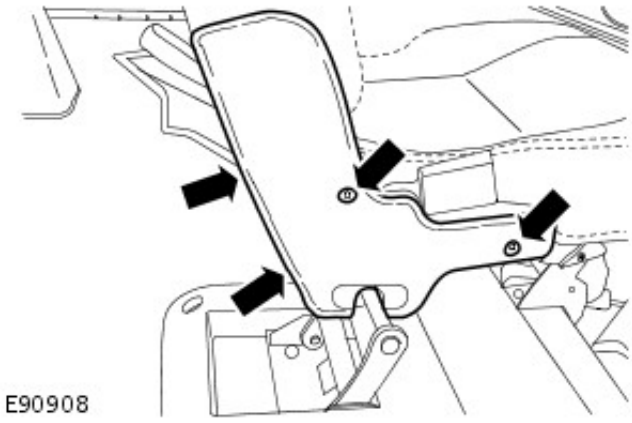
1. Position seat belt assembly to D-pillar and tighten bolt to 32 Nm (24 lb.ft).
2. Extend seat belt and position through D-pillar post finisher.
3. Install and tighten seat belt upper and lower securing bolts to 32 Nm (24 lb.ft).

4. Secure D-pillar post finisher to body upper rail.
5. Install belt guide to D-pillar post finisher and install finisher retaining studs.
6. Install cap to seat belt bolt.

Safety Belt System - Rear Safety Belt Buckle LH

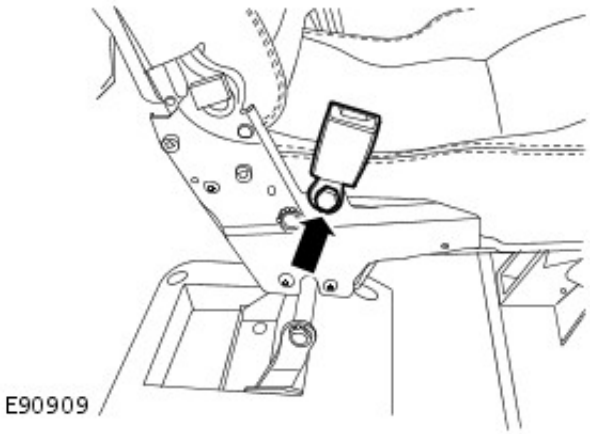
Removal and Installation

Removal



1. Remove the LH rear seat inner hinge trim panel.

- Remove the 4 screws.



2. Remove the LH rear safety belt buckle.

- Remove the bolt.

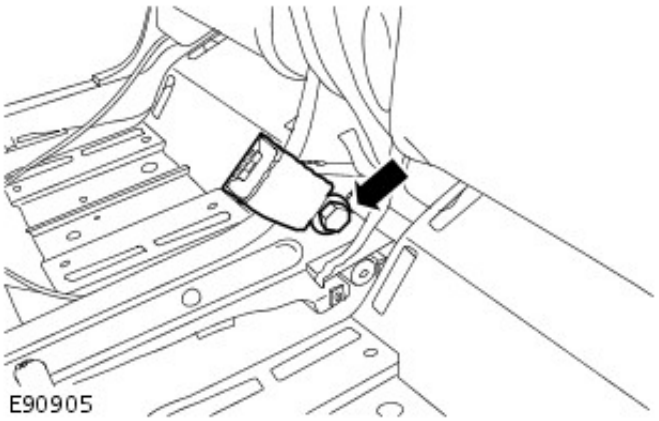
Installation

1. To install, reverse the removal procedure.

- Tighten the bolt to 31 Nm (23 lb.ft)

Safety Belt System - Rear Safety Belt Buckle RH

Removal and Installation



Removal

1. Remove the rear seat cushion.
   For additional information, refer to: Rear Seat Cushion (501-10 Seating, Removal and Installation).
2. Remove the RH rear safety belt buckle.
   - Remove the bolt.

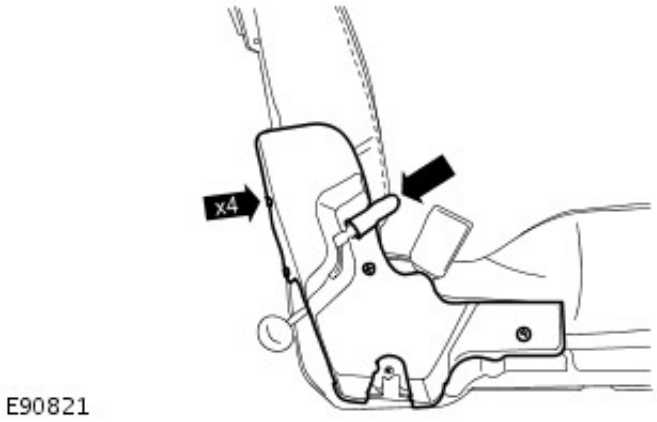
Installation

1. To install, reverse the removal procedure.
   - Tighten the bolt to 31 Nm (23 lb.ft).

Safety Belt System - Third Row Safety Belt Buckle

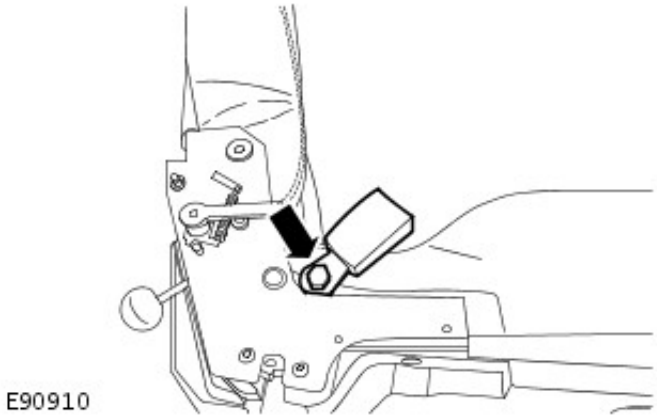
Removal and Installation

Removal



1. Remove the third row seat inner hinge trim panel.

- Remove the third row seat recliner handle.
- Remove the 4 screws.



2. Remove the third row safety belt buckle.

- Remove the bolt.

Installation

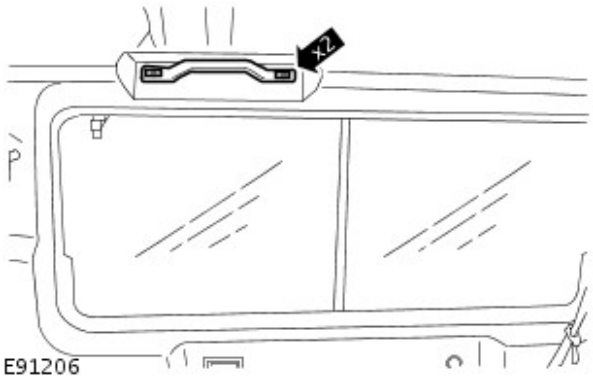
1. To install, reverse the removal procedure.

- Tighten the bolt to 31 Nm (23 lb.ft).

Safety Belt System - Third Row Safety Belt Retractor

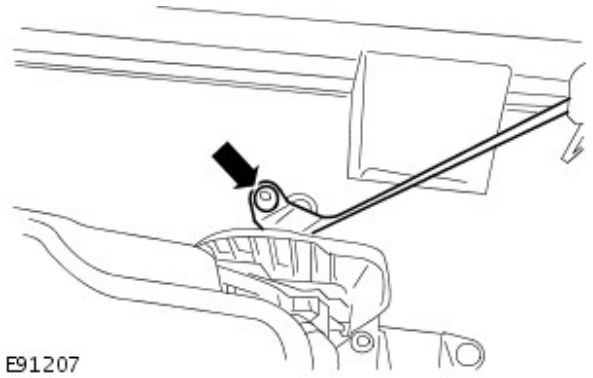
Removal and Installation

Removal



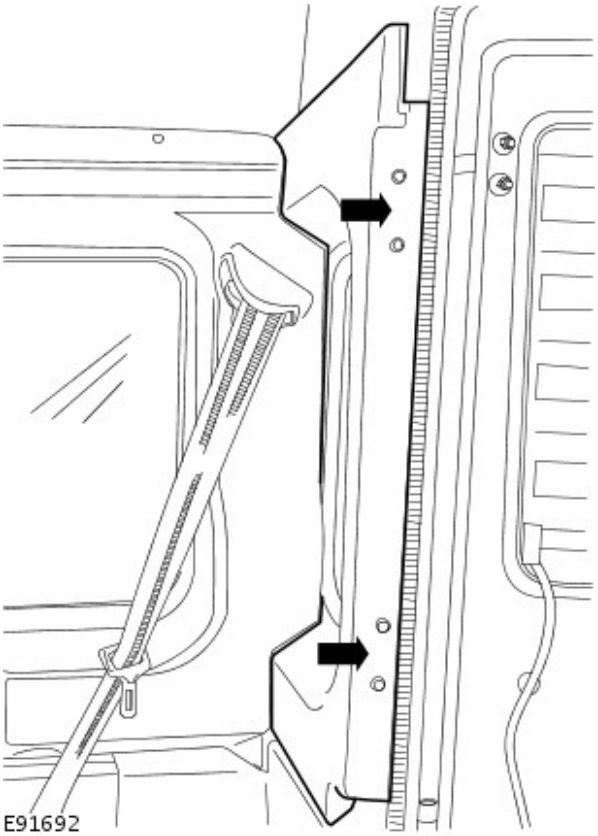
1. Remove the grab handle.

- Remove the 2 grab handle screw covers.
- Remove the 2 screws.



2. Release the third row safety belt lower anchor.

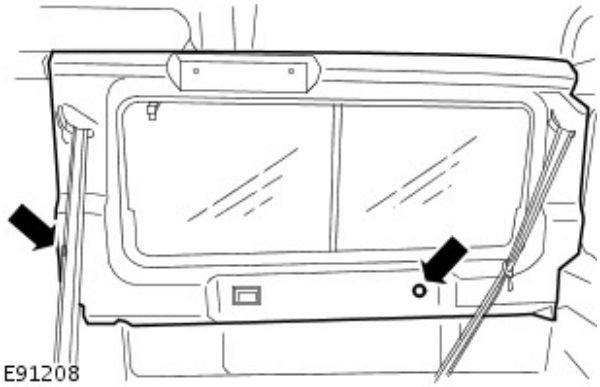
- Remove the bolt.



3. Remove the rear quarter trim panel.

- Release the 2 clips.

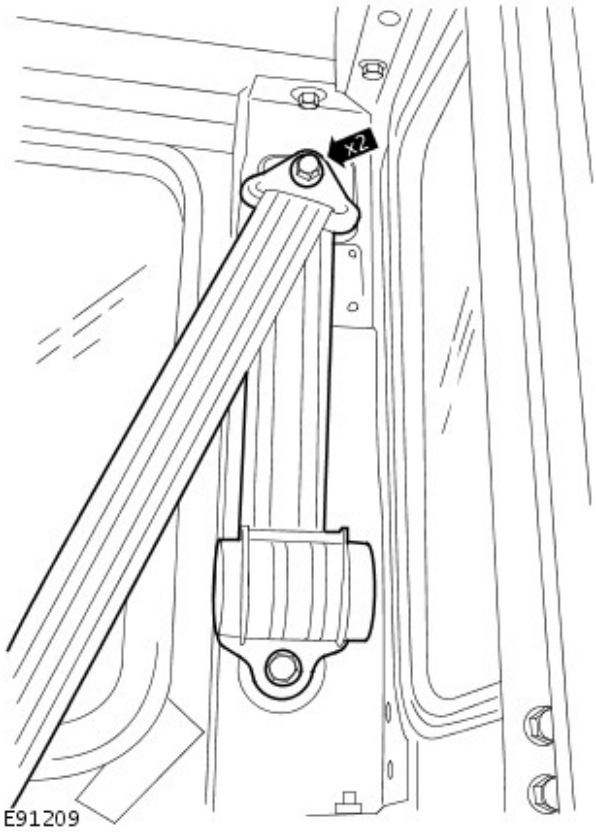
4. Reposition the C-pillar trim panel.



- Remove the 2 lower clips.
- Move the C-pillar trim panel upwards to release the 2 upper clips.

5. Remove the third row safety belt retractor.

- Remove the 2 bolts.



Installation

1. Install the third row safety belt retractor.

- Tighten the bolts to 31 Nm (23 lb.ft).

2. Secure the C-pillar trim panel.

- Install the clips.

3. Install the rear quarter trim panel.

- Secure with the 2 clips.

4. Secure the third row safety belt lower anchor.

- Tighten the bolt to 31 Nm (23 lb.ft).

5. Install the grab handle.

- Tighten the screws.
- Install the grab handle screw covers.

Body Repairs - General Information - Body Repairs

Description and Operation

General Information

Body shells are of rivetted, bolted and welded construction and are bolted to the chassis frame.

It is essential that design dimensions and strength are restored in accident rectification. It is important that neither structural weakness nor excessive local stiffness are introduced into the vehicle during body or chassis repair.

Repairs usually involve a combination of operations ranging from straightening procedures to renewal of either individual panels or panel assemblies. The repairer will determine the repair method and this decision will take into account a balance of economics between labour and material costs and the availability of repair facilities in both equipment and skills. It may also involve considerations of vehicles down-time, replacement vehicle availability and repair turn-around time.

It is expected that a repairer will select the best and most economic repair method possible, making use of the facilities available. The instructions given are intended to assist a skilled body repairer by expanding approved procedures for panel replacement with the objective of restoring the vehicle to a safe running condition and effecting a repair which is visually acceptable and which, even to the experienced eye, does not advertise the fact that it has been damaged.

This does not necessarily mean that the repaired vehicle will be identical in all respects with original factory build. Repair facilities cannot always duplicate methods of construction used during production.

The panel repairs shown in this section are all based on a 110 Station Wagon. Therefore all illustrations and text relate only to this model. Although certain areas of the vehicle, such as the front end, are relevant to all models.

Operations covered in this Manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and suspension geometry checked after completion and if necessary a road test of the vehicle is carried out, particularly where safety related items are concerned.

Where major units have been disconnected or removed, it is necessary to ensure that fluid levels are checked and topped up when necessary. It is also necessary to ensure that the repaired vehicle is in a roadworthy condition in respect of tyre pressures, lights, washer fluid etc.

Body repairs often involve the removal of mechanical and electrical units as well as associated wiring. Where this is necessary use the relevant section in this manual.

Taking into consideration the differences in body styles, steering and suspension systems as well as engine and suspension layouts, the location of the following components as applicable to a particular vehicle is critical:

- Front suspension upper damper mountings
- Front suspension or sub frame mountings
- Engine mountings on RH and LH chassis longitudinals
- Rear suspension upper damper mountings
- Rear suspension mountings or lower pivots
- Steering rack mountings

Additional points which can be used to check alignment and assembly are:

- Inner holes in cross member - side - main floor
- Holes in valance front assembly
- Body to chassis mounting holes
- Holes in rear floor
- Holes in rear lower panels or extension rear floor
- Fuel tank mountings

Apertures for windscreen, backlight, bonnet and doors can be checked by offering up an undamaged component as a gauge and also by measuring known dimensions.
For additional information, refer to: Body and Frame (501-26 Body Repairs - Vehicle Specific Information and Tolerance Checks, Description and Operation).

Straightening

Whenever possible, chassis structural members should be cold straightened under tension. Do not attempt to straighten with a single pull, but rework the damaged area using a series of pulls, releasing tension between each stage and using the opportunity to check alignment.

Body jig

Unless damage is limited to cosmetic panels, all repair work to body members must be carried out on a body jig, to ensure that impact damage has not spread into more remote parts of the body structure. Mounting on a jig will also ensure that the straightening and panel replacement procedures do not cause further distortion. If original dimensions cannot be satisfactorily restored by these methods, damaged structural members should be replaced. Damaged areas should be cut away using a high speed saw, NOT an oxy-acetylene torch.

As a rule, body dimensions are symmetrical about the centre line. A good initial check for distortion is therefore to measure diagonally and to investigate apparent differences in dimensions.

Inspection

Every accident produces individual differences in damage. Each repair is influenced by the extent of the damage and by the facilities and equipment available for its rectification.

Most accident damage can be visually inspected and the approximate extent of the damage assessed. Sometimes

deformation will extend beyond the area of direct damage, and the severity of this must be accurately established so that steps may be taken to restore critical body components to their original dimensions.

An initial check of critical dimensions can be carried out by means of drop checks or (preferably) trammels. Gauges are available which will check accurately for body twist. Where repairs necessitate renewal of a critical body component it is recommended that a body jig is used.

ELECTRONIC CONTROL UNITS (ECU's)

The ECU's fitted to Defender vehicles make it advisable to follow suitable precautions prior to carrying out welding repair operations. All ECU's must be disconnected before any welding operations take place. Harsh conditions of heat and vibration may be generated during these operations which could cause damage to the units.

PAINT PROCEDURES

Replacement Panels

Service panels are supplied with a cathodic primer coating as part of the panel protection, and in compliance with the vehicle's Corrosion Warranty where applicable. DO NOT remove this primer before paint refinishing. In the event of localised surface damage or imperfections, ensure that the minimum of primer is removed during rectification work for effective repair.

Rectify damage by panel beating or straightening. To remove corrosion or paint runs on outer surfaces, abrade primer coat in the affected area as necessary using the following procedure:

- Clean the panel using a solvent wipe.
- Treat exposed areas of metal with an etch phosphate process.
- Re-treat the affected area using either a separate acid-etch primer and two-pack surfacer, or an integrated etch primer/filler.

Bolted Panels

Before fitting bolt-on panels, ensure that all mating and adjacent surfaces on the vehicle and replacement panel are free from damage and distortion. Rectify if necessary as described in this section, and apply preformed strip sealer where specified.

Welded Panels

- Remove primer from the immediate vicinity of new and existing panel flanges, cleaning to bright metal finish.
- On joints to be spot welded, apply weld-through zinc rich primer to joint faces of both flanges. Make spot welds while primer is still wet or according to the manufacturer's instructions.
- Dress accessible weld seams.
- Clean panel using solvent wipe.
- Treat bare metal with an etch phosphate process.
- Re-treat repaired areas.
- It is not satisfactory to use weld-through, zinc rich primers in conjunction with MIG welding.

Sectioned Panels

When replacing part or sectioned panels, the basic procedure is the same as for welded panels described above, with the following variations:

1. Remove primer from both new and existing joint faces, cleaning to a bright metal finish.

2. Where an overlap joint with the existing panel is to be spot welded, apply weld-through, zinc rich primer to both joint faces and spot weld while the primer is still wet or according to the manufacturer's instructions.

3. MIG weld joints where applicable.

4. Clean the panel with a solvent wipe.

5. Treat bare metal areas using an etch phosphate process.

6. Re-prime affected areas as necessary as for rectifying transit damage. See this section.

7. Treat the inner faces of lap or butt joints with a suitable cavity wax. See Sealing and Corrosion Protection.

Clinch Panels (eg Door skins etc.)

1. Abrade primer on new and existing panel joint faces, and clean using a solvent wipe.

2. Apply metal-to-metal adhesive where applicable.

3. Where joints are to be spot welded, apply suitable weld-through, zinc rich primer to weld areas.

4. Where joints are to be MIG welded, apply zinc rich primer in adjacent areas but leave the welded area untreated.

5. To retain the panel whilst clinching the flanges, tack spot weld or plug weld as appropriate.

6. Clean the panel with a solvent wipe.

7. Treat bare metal areas with a suitable etch phosphate process.

8. Re-prime affected areas as necessary as for rectifying transit damage. See this section.

9.Replacement doors, bonnets and tailgates must be treated with a suitable seam sealer on clinched seams, following the primer coat.

Paint Refinishing

1. Seal all accessible exterior and interior seams with an approved seam sealer. Certain joints such as sill lower flange seams must be left unsealed.

2. Apply a suitable anti-chip primer where specified.

3. Apply a two-pack paint refinishing system.

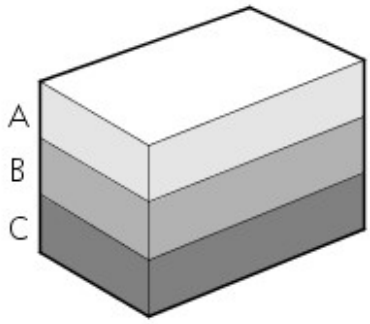
4. Repair any damage to underbody sealers either at this stage or before paint operations.

Paint Repairs

Before carrying out paintwork repairs, the vehicle must be thoroughly cleaned using either a steam cleaner or high-pressure washer.

Wash locally repaired areas using a mild water-mixable detergent and wipe them clean with solvent, immediately prior to paint application.

Abrade damaged paintwork where bare metal has been exposed until the metal is clean and extends beyond the area of immediate damage. Treat the bare metal with an etch phosphate to remove all traces of rust and provide a key for new paint coats. Re-treat the affected area using either a separate acid-etch primer and two-pack surfacer or an integrated etch primer/filler, and follow with a two-pack paint system. Those surfaces not receiving paint must be treated with a cavity wax following paint operations.



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Item	Part Number	Description
A	-	Two-pack top coat
B	-	Two-pack primer filler and etch primer
C	-	Etch phosphate

GENERAL WELDING PRECAUTIONS

The following pages show the procedures to follow when using welding for repairs. No resistance spot welds have been used in any of the repairs.

The aluminium alloy used on all Defender models is a combination of aluminium and magnesium. When converting a MIG welder for use on aluminium it is essential the following components are changed. The materials shown in brackets are the correct materials to use:

When carrying out welding operations the following criteria must be observed:

M772122

Item	Part Number	Description
A	-	MIG Plug welds
B	-	MIG seam weld

Seat Belt Anchorages

Seat belt anchorages are safety critical. When making repairs in these areas it is essential to follow design specifications.

Where possible, the original production assembly should be used, complete with its seat belt anchorages, or the cut line should be so arranged that the original seatbelt anchorage is not disturbed.

WARNING: Body parts incorporating seat belt anchorages MUST be renewed completely if damaged beyond repair, as the welds in these areas are safety critical and cannot be disturbed.

All welds within 250mm (9.9in.) of seat belt anchorages must be carefully checked for weld quality, including spacing of spot welds. A crack detection process must be carried out in these areas.

PANEL REPLACEMENT PROCEDURE

General

This information is designed to explain the basic panel removal and replacement method. This standard method may vary slightly from one vehicle to another. The main criterion in removal and replacement of body panels is that Land Rover's original standard is maintained as far as possible.

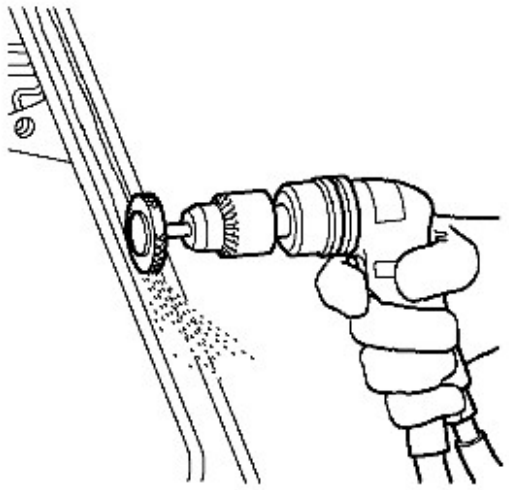
All repair processes and procedures shown relate to Aluminium panels.

Remove Panel

WARNING: Ensure breathing mask and protective glasses are worn during operations where Aluminium particles are removed.

CAUTION: Never use a sanding disc that has previously been used on steel, as iron deposits could be left on the surface of the Aluminium.

• NOTE: In wheel arch areas it may be necessary to soften underbody coating using a hot air gun, prior to exposing spot welds.



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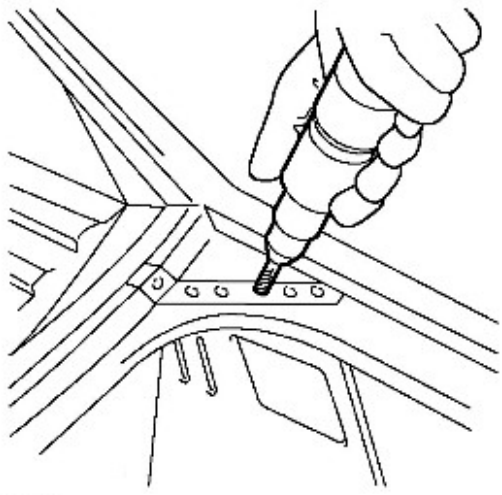
1. Expose resistance spot welds. For those spot welds which are not obviously visible, use a rotary drum sander or wire brush fitted to an air drill, or alternatively a hand held wire brush.



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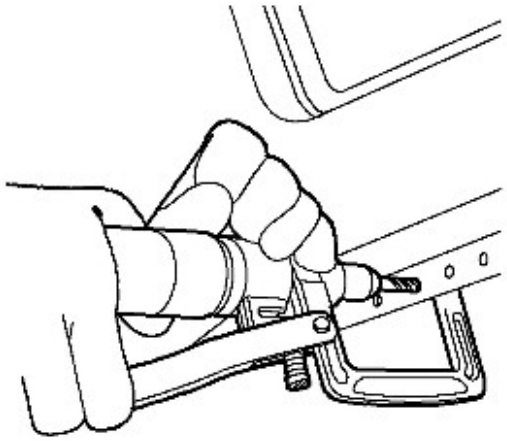
2. Cut out welds using a cobalt drill.



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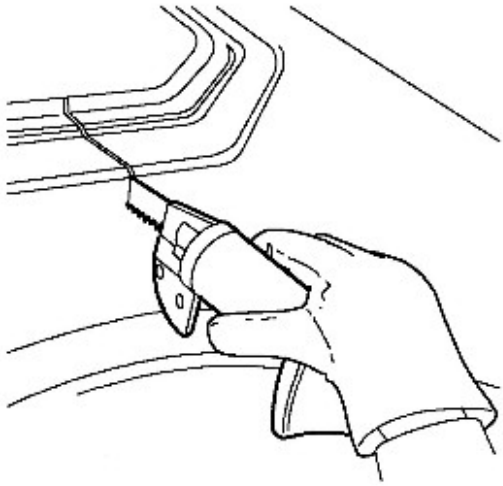
3. Alternatively, use a clamp-type spot weld remover.



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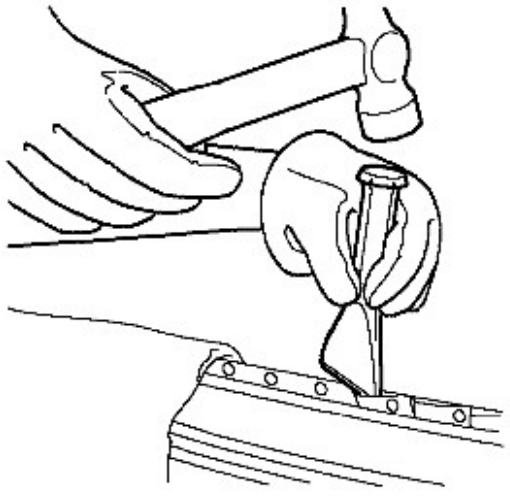
4. Cut away the bulk of the panel as necessary using an air saw.

• NOTE: On certain panel joints MIG welds and braze should be removed using a sander where possible, before cutting out the panel bulk.



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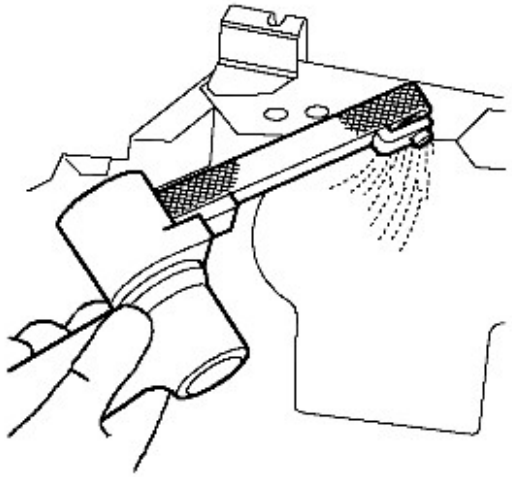
5. Separate the spot welded joints and remove panel remnants using hammer, bolster chisel and pincers.

Prepare old surfaces



77M1362

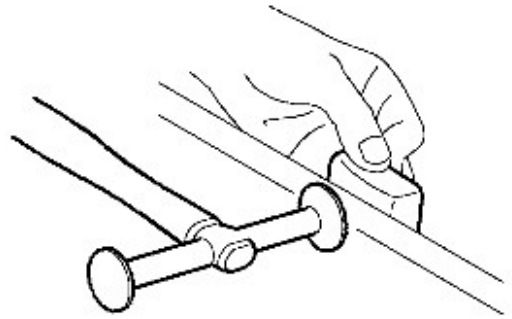
6. Clean all panel joint edges to a bright smooth finish, using a belt type sander.

WARNING: Care must be taken to avoid excessive heat build up which may be caused by this equipment.

CAUTION: Where significant straightening is required, heat must be applied to the area to avoid stretching the Aluminium.

All tools used for working with Aluminium must be kept separate from those used on steel.

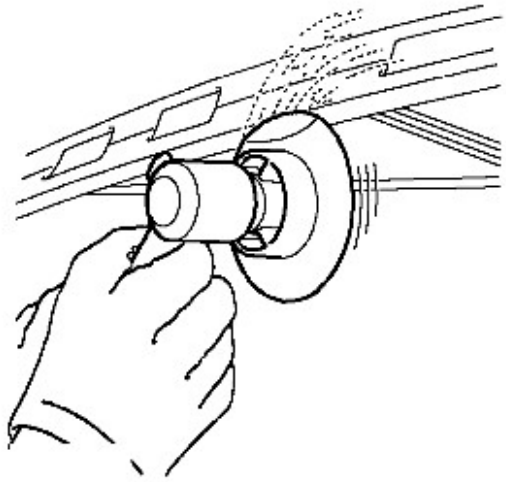
• NOTE: Prior to sanding, remove remaining sealant using a hot air gun to minimise the risk of toxic fumes caused by generated heat.



M771720

7. Straighten existing joint edges using shaping block and hammer.

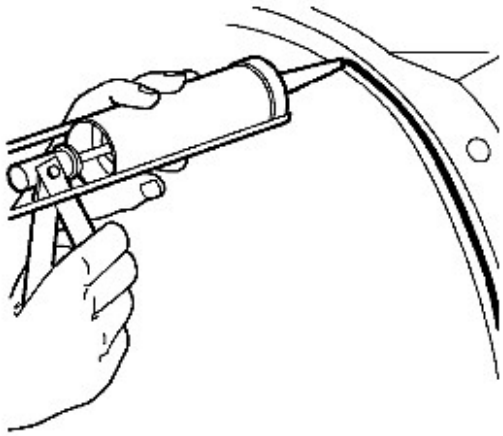
Prepare new surfaces



77M1366

8. Prepare new panel joint edges for welding by sanding to a bright finish,. This must include inner as well as outer face.

9. Drill holes in new panel, in the equivalent spot weld positions.



77M1368

10. Apply adhesive sealant to panel joint surfaces.

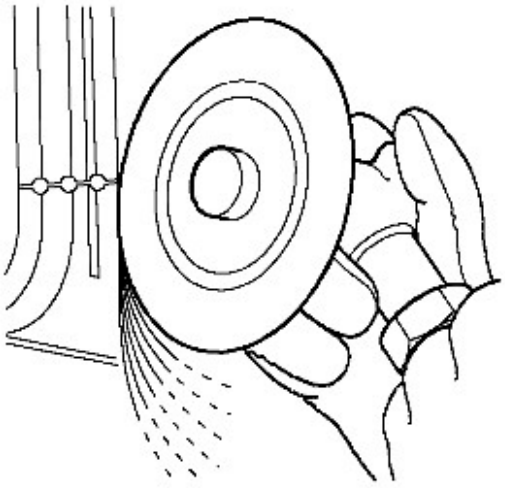
CAUTION: Do not use Petroleum Spirit, Alcohol or Paint Thinners to clean mating faces.

11. All mating faces that have sealant applied to them must be cleaned using a suitable solvent. The majority of aluminium sealants have a primer/pre-treatment included with them.

Offer up and align

Offer up new panel and align with associated panels. Clamp into position using welding clamps or Mole grips. Where a joggle or brace joint is being adopted, make a set in the original panel joint edge or insert a brace behind the joint.

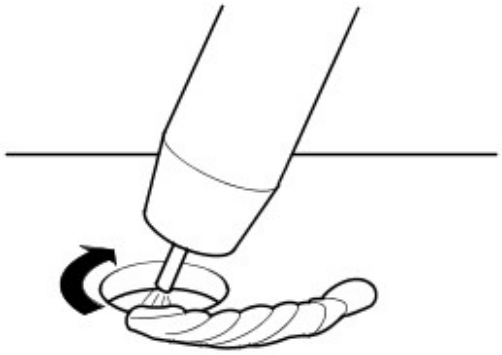
• NOTE: In cases where access for welding clamps is difficult, it may be necessary to use tack welds.



77M1373

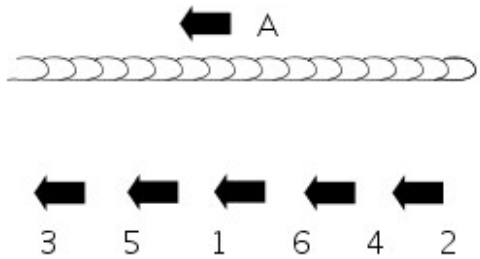
12. Dress MIG tack welds using a sander with 36 grit disc or a belt type sander where access is limited.

Welding



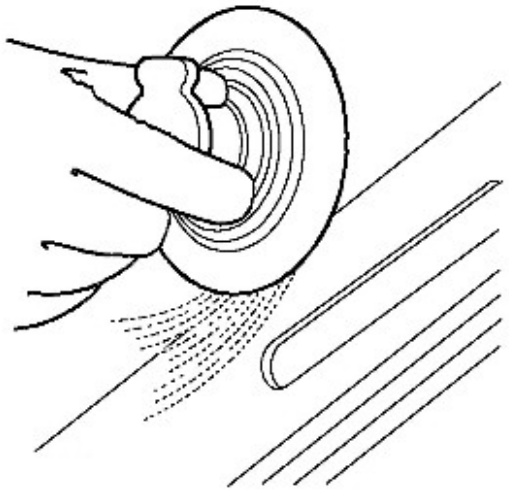
M772123

13. When plug welding, begin weld approximately 15 mm (0.6 in) from hole. This will allow the weld area to be preheated which will enhance weld penetration. It will also allow the operator to see more easily where penetration takes place. Fill hole with weld by moving in a circular direction around the hole.



M772124

14. When MIG seam welding, do not carry out lengthy operations. Divide the welds into short operations, this will reduce the chances of overheating the work piece which in turn will avoid distortion and strain.



77M1376

CAUTION: Only use a Stainless Steel wire brush for Aluminium.

15. Dress all welds using a sander with 36 grit disc or a belt type sander and/or wire brush.

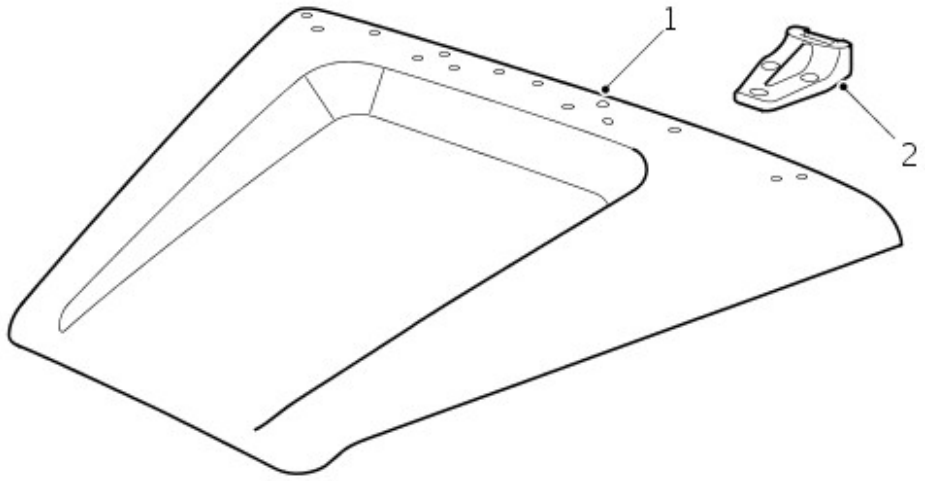
Body Trim

The panel repair operations itemise body trim components which must be removed for access during each repair

Because of the unpredictable nature of accident damage, the items listed make no allowance for any difficulties which may be found in removal and only apply to an undamaged vehicle. No allowance is made for any difficulties which may be found during panel removal. Damaged body trim items must be renewed as necessary following body repairs.

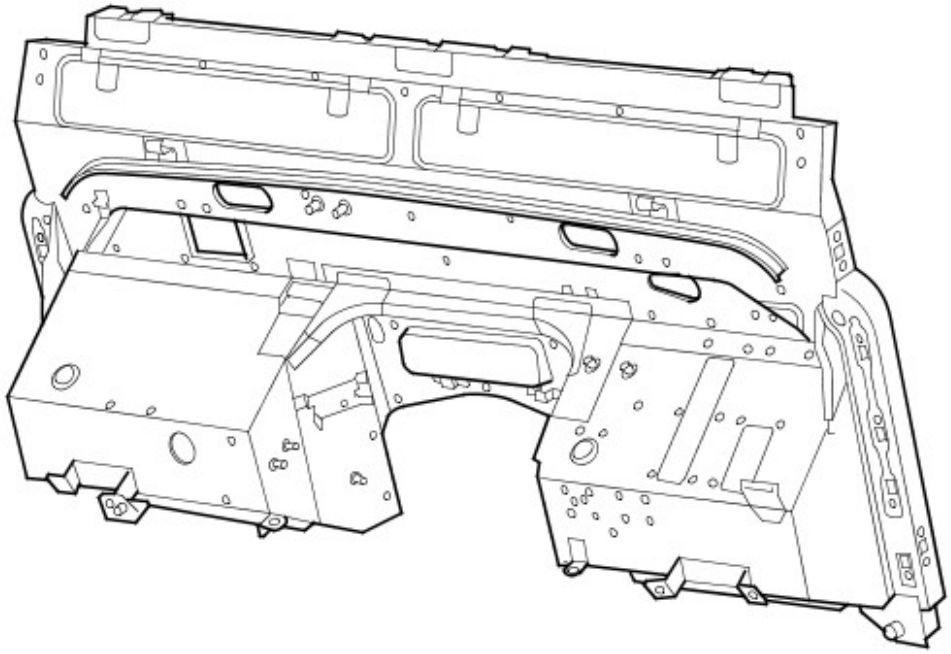
SERVICEABLE PANELS

Front end panels



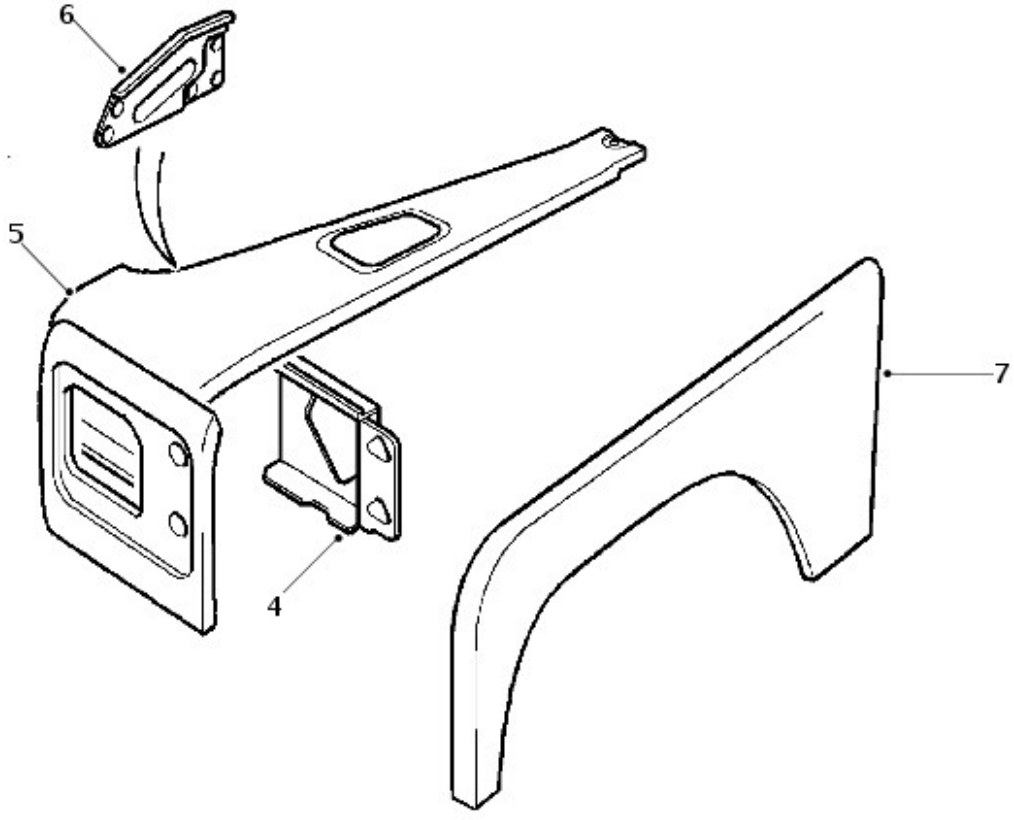
M772097A

Item	Part Number	Description
1.	-	Hood
2.	-	Hinges



M772076A

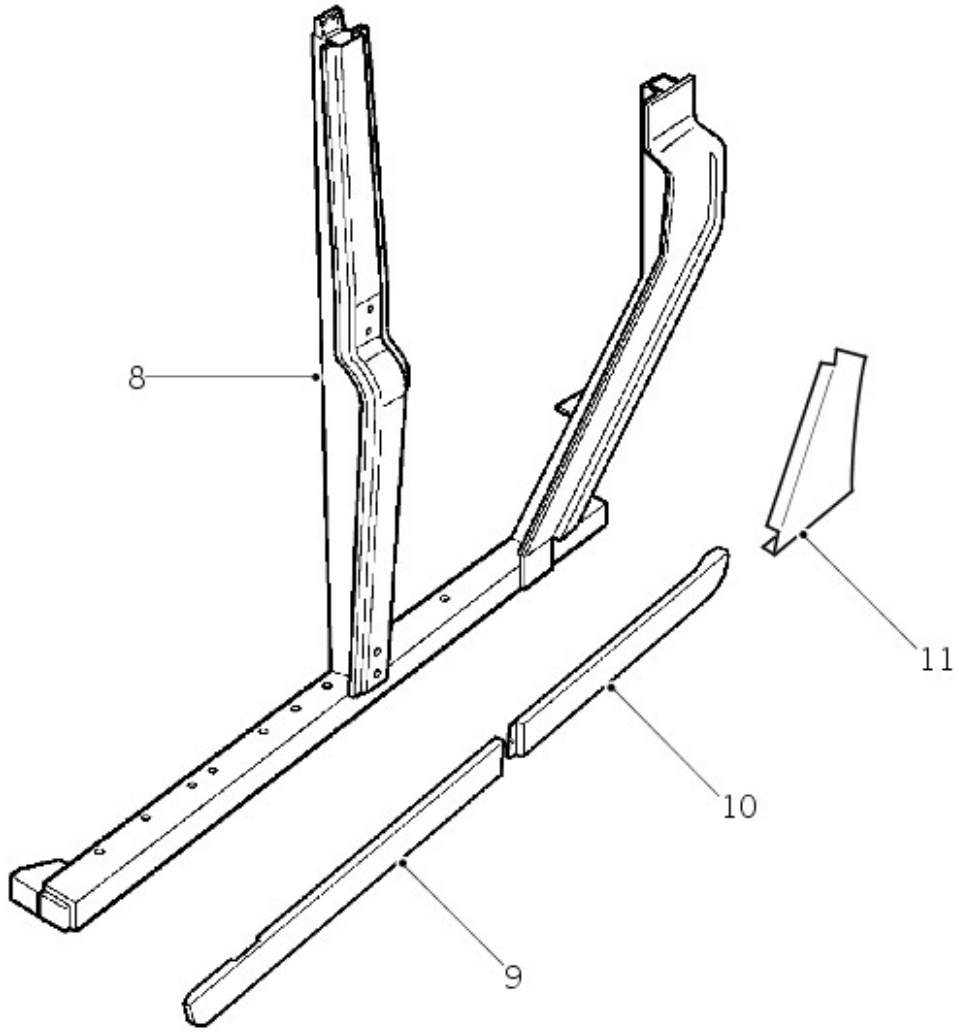
Item	Part Number	Description
3.	-	Bulkhead



M772095C

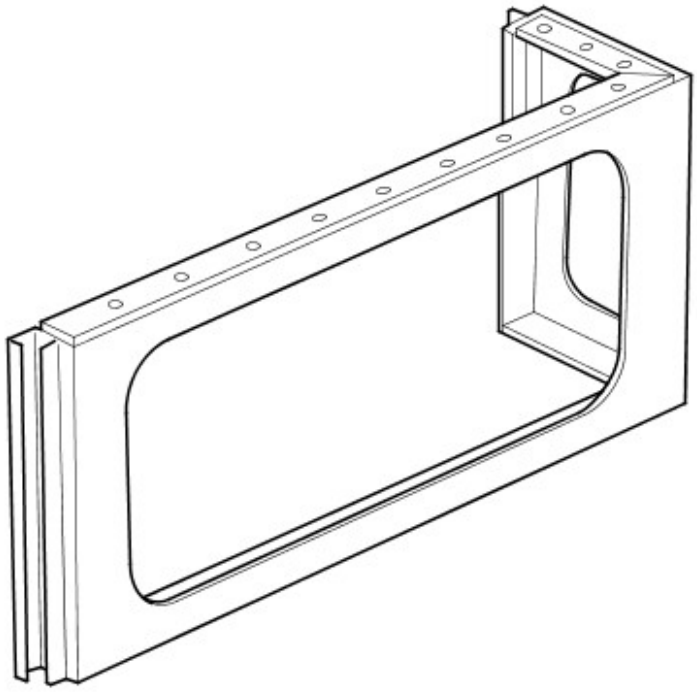
Item	Part Number	Description
4.	-	Headlamp mounting panel - inner
5.	-	Fender upper assembly
6.	-	Headlamp reinforcement panel
7.	-	Fender lower

Body side panels



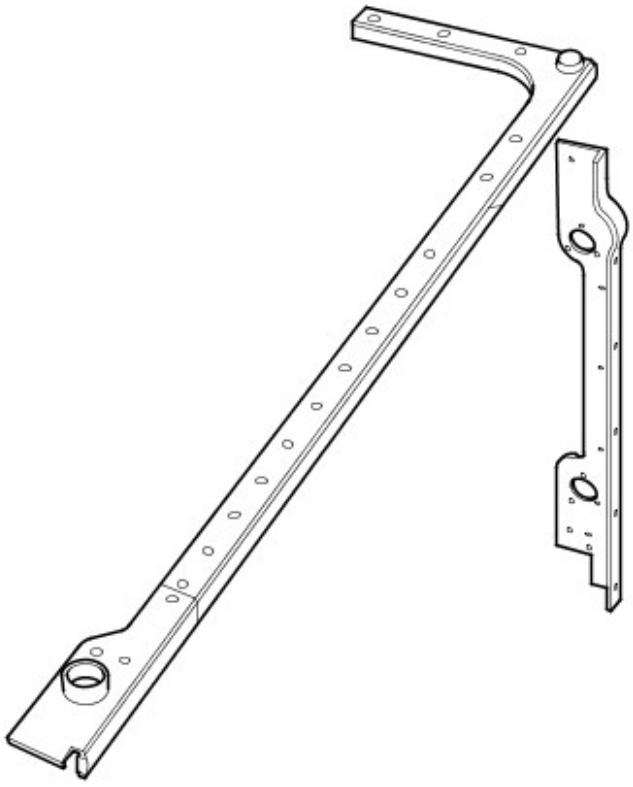
M772110B

Item	Part Number	Description
8.	-	'B/C' and 'D' post assembly
9.	-	Rocker panel - front
10.	-	Rocker panel - rear
11.	-	Dogleg - lower panel



M772104A

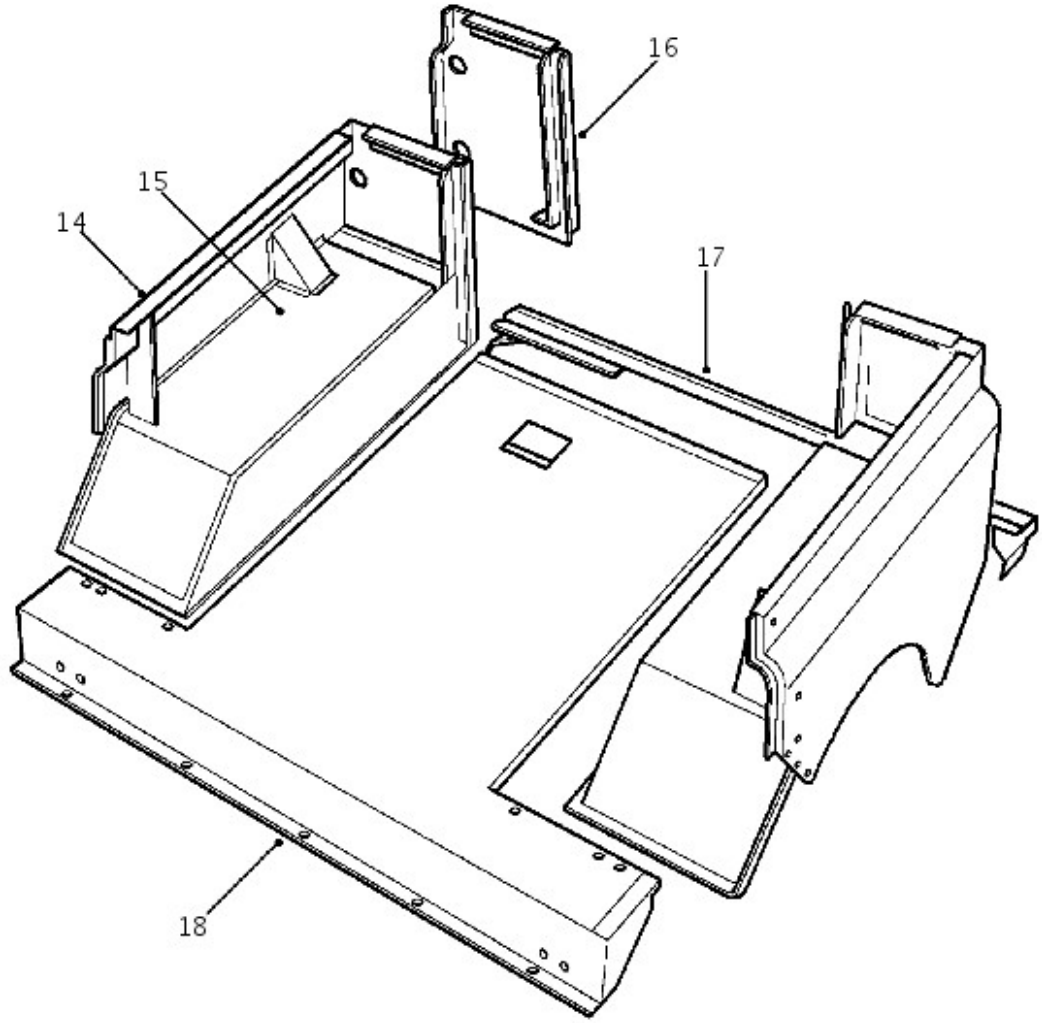
Item	Part Number	Description
12.	-	Body side rear - upper



M772100A

Item	Part Number	Description
13.	-	Body side cappings

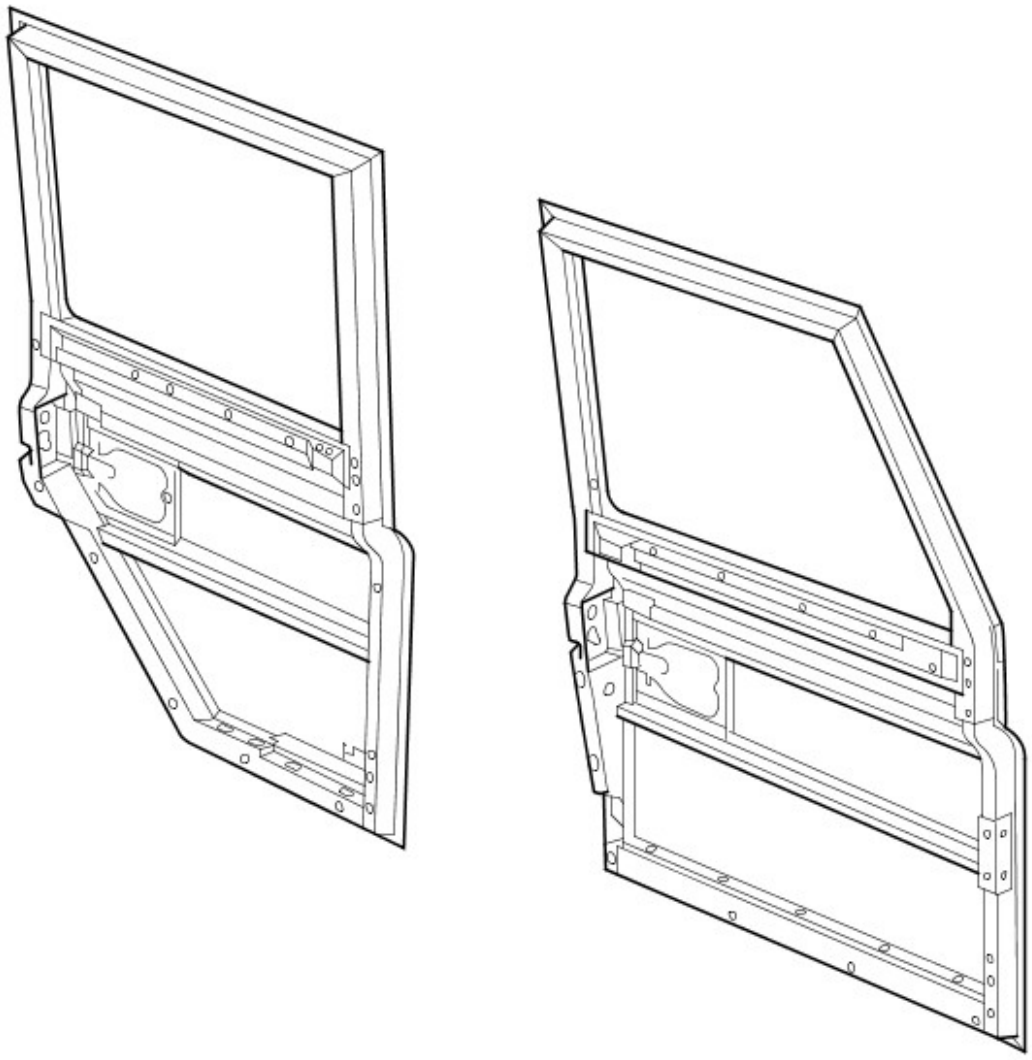
Rear end panels



M772094B

Item	Part Number	Description
14.	-	Body side panel - lower
15.	-	Body side panel - lower - assembly
16.	-	Rear lamp panel
17.	-	Rear panel
18.	-	Rear floor

• NOTE: From 2002 Model year, the taildoor skin is one panel.



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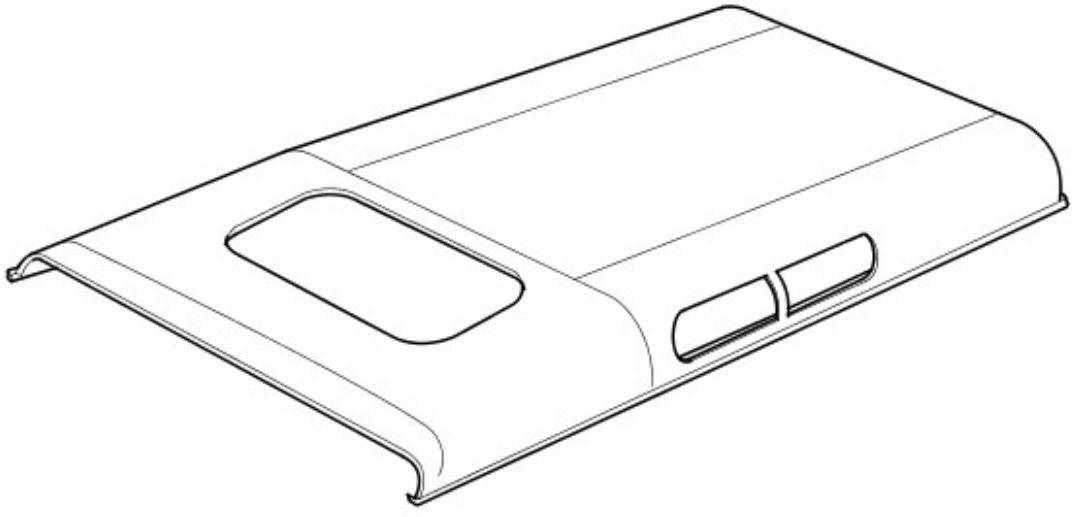
Item	Part Number	Description
19.	-	Door assemblies



M772092A

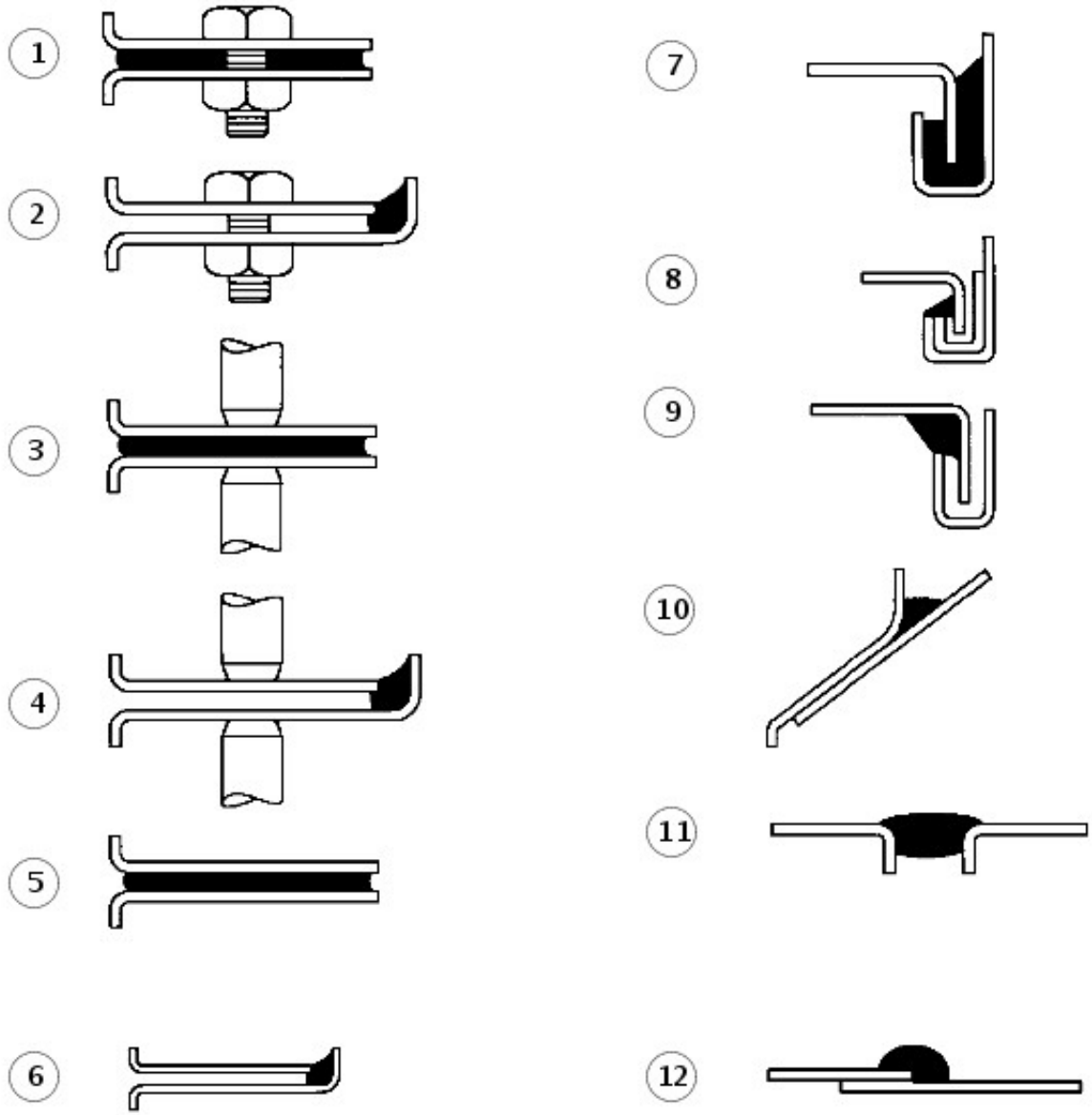
Item	Part Number	Description
20.	-	Roof

Body Repairs - Corrosion Protection - Corrosion Protection

Description and Operation

APPROVED MATERIALS

Joint types



77M1584

Item	Part Number	Description
1.	-	Between bolted panels
2.	-	Between bolted panel edges
3.	-	Between spot welded panels
4.	-	Between spot welded panel edges
5.	-	Between bonded panels
6.	-	Between bonded panel edges
7.	-	Clinch joints (type a)
8.	-	Clinch joints (type b)
9.	-	Clinch joints (type c)
10.	-	Gaps between panels (type a)
11.	-	Gaps between panels (type b)

12.	-	Lap joint

DESCRIPTION USAGE	SUPPLIER	PART NUMBER
CAVITY WAXES		
Inner cavity wax (transparent)	3M	(08909, 08919, 08929)
Inner cavity wax (amber)	3M	(08901, 08911, 08921)
Cavity wax	Croda	(PW57)
ENGINE BAY WAXES/LACQUERS		
Atrolan engine bay wax and cosmetic wax	Astors	DA3243/1
Engine bay cosmetic wax/lacquer	Croda	PW197
Engine bay cosmetic wax/lacquer	Dinal	4010
MISCELLANEOUS MATERIALS		
Flexible parts repair - rubber modified polypropylene parts	3M	(05900)
Aerosol Auto adhesive (trim) - impact adhesive for trim parts	3M	(08080)
Water shedder repair	Tereson	
Sound dampening foam	Gurit Essex	Betacore 7999
SEAM SEALERS		
Body caulking - type (b) gaps between panels	3M	08568
Drip Chek Clear - bolted, spot welded and bonded panel edges; type (a) and (b), gaps between panels; type (c) clinch joints	3M	08401
Drip Chek Heavy - type (b), gaps between panels; type (c) clinch joints	3M	08531
Flexseal Polyurethane Seam Sealer - bolted, spot welded and bonded panel edges; type (a) and (b), gaps between panels; type (c) clinch joints	3M	(08684, 08689, 08694)
Polyurethane Sealer (sachet)	3M	(08703, 08783, 08788)
Sprayable sealer - type 12 lap joints	3M	(08800, 08823)
Super seam sealer - type 12 lap joints	3M	(08357)
Weld Thru Sealer - between spot welded panels	3M	(08625)
Betafill Clinch and Brushable Sealer (Black, Grey, White)	Gurit Essex	10211/15/20
Clinch joint and underbody coating (Grey, Beige)	Gurit Essex	(10101, 10707)
Leak-Chek Clear - between bolted panels; spot welded and bonded panel edges; type (c) clinch joints	Kent industries	(10075)
Putty - type (a) and (b) gaps between panels	Kent industries	
Polyurethane seam sealer - between bolted panels, spot welded and bonded panel edges; type (a) and (b), gaps between panels	PPG	(6500)
Polyurethane seam sealer - between bolted panels, spot welded and bonded panel edges; type (a) and (b), gaps between panels	Teroson	92
Terolan Light seam sealer - bolted, spot welded and bonded panel edges; type (a) and (b), gaps between panels; between bonded panels; type (c) clinch joints	Teroson	
Terosan Special Brushable Seam sealer - lap joints 12	Teroson	
Terostat Sprayable seam sealer - bolted, spot welded and bonded panel edges; type (a) and (b), gaps between panels	Teroson	9320
Terostat 1K PU seam sealer (SE20) - type (a) and (b), gaps between panels , spot welded and bonded panel edges;	Teroson	
Sealing compound - bolted, spot welded and bonded panel edges; type (b), gaps between panels	Wurths	8901001/-/6
STRUCTURAL ADHESIVES		
Automotive structural adhesive - between bonded panels; type 5 and 7	3M	08122
Two part structural Epoxy - between bonded and spot welded panels; type (a) clinch joints	Ciba Geigy	XB5106/7
UNDERBODY SEALERS		
Body Schutz	3M	08861
Spray Schutz	3M	08877
Crodapol Brushable Sealer	Croda	PV75
Terotex Underseal (CP02)	Terosan	9320
UNDERBODY WAXES		
Stone chip coating (smooth)	3M	08158/9
Underbody wax	Croda	PW61

Underbody wax	Dinol	Tectacote 205
WELD-THRU PRIMERS		
Weld-thru coating	3M	05913
Zinc spray	3M	09113
Zinc rich primer	ICI	P-565 634

APPLICATION EQUIPMENT

SATA Schutz Gun Model UBE

Specifications	
Air consumption	200 litres/min (7 ft³/min) @ 45 psi
Weight	660 grams (23.3 oz)

Manufactured and supplied by:

Sata Gmbh

Minden Industrial Ltd.

16 Greyfriars Road

Moreton Hall

Bury St. Edmunds

Suffolk IP32 7DX

Tel. (01284) 760791

The Sata Schutz Gun is approved for the re-treatment of vehicle underbody areas with protective coatings as supplied in 1-litre (1.76pt.), purpose-designed, 'one-way' containers. The screw thread fitting (female on the gun) will fit most Schutz-type packs.

- NOTE: Always clean gun after use with the appropriate solvent.

Full operating details are supplied with the equipment.

Sata HKD1 Wax Injection Equipment

The Sata HKD1 is approved by Land Rover for use in all cavity wax re-treatment operations. The equipment comprises a high quality forged gun with 1-litre capacity pressure feed container, a flexible nylon lance, 1100 mm (43.3 in) straight steel lance and hooked wand lance. A quick-change coupling is a standard fitting to enable lances to be easily interchanged. The lances each have their own spray pattern characteristics to suit the type of box section to be treated.

The Sata HKD1 is covered by a 12 month warranty. All replacement parts and service are obtainable from the suppliers.

Cooper Pegler Falcon Junior Pneumatic (Airless)

Manufacturer and supplier:

Cooper Pegler and Co. Ltd.

Burgess Hill

Sussex RH15 9LA

Tel. 04 446 42526

Intended primarily for applying transit wax, the Falcon Junior pneumatic sprayer has a 5-litre (1 gal.) container with integral hand pump. This high quality unit provides a simple and effective means of wax spraying without the need for compressed air or additional services.

A selection of nozzles, lances and hoses together with a trigger valve assembly incorporating a filter enable the sprayer to be used in a variety of applications. These include general maintenance, wax injection and paint application. All parts are fully replaceable and include a wide range of nozzle configurations.

The Falcon Junior is fitted with Viton seals and is guaranteed for 12 months.

3M Application Equipment

Manufacturer:

3M UK PLC

Automotive Trades Group

3M House

PO Box 1

Market Place

Bracknell

Berks. RG12 1JU

Tel. (01344) 858611

All 3M equipment is available from local trade factors or 3M refinishing factors.

3M Caulking Gun 08002

A lightweight, robust metal skeleton gun designed to accommodate 325 mm (12.8 in) cartridge for dispensing sealants etc. This gun facilitates rapid cartridge loading and features a quick-release lever for accurate material ejection and cut-off control.

3M Pneumatic Cartridge Gun 08012

An air line fed gun for application of 3M cartridge products. Excellent ease of application for a smooth sealant bead, and incorporates a regulator valve for additional control.

Other 3m applicator equipment available:

3M Pneumatic Applicator Guns

Air line fed gun for application of 3M sachet sealers (Part No. 08006 for 200 ml (6 fl oz) and 310 ml (9 fl oz) sachets, and Part No. 08007 for all size sachets including 600 ml (18 fl oz).

3M Applicator Gun 08190

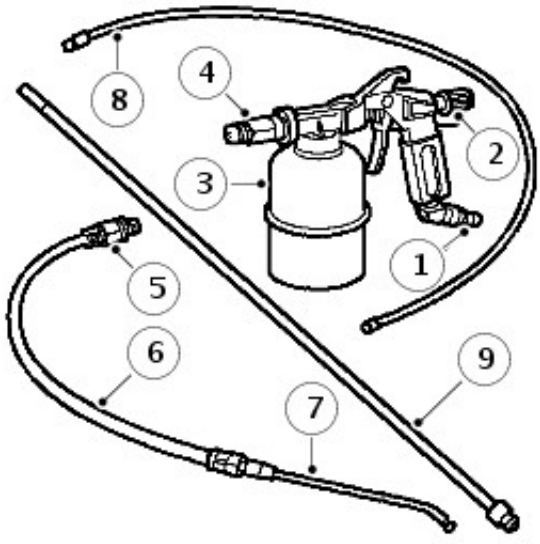
For application of 3M Structural Adhesive 08120.

3M Inner Cavity Wax Applicator Gun

Features 750 mm (29.6 in) flexible tube and using 1-litre (1.76 pt) canisters, this approved equipment is available from all 3M refinishing factors.

Heavy Duty Manual Gun

Cavity wax application equipment and techniques



77M1383

Item	Part Number	Description
1.	-	Air inlet
2.	-	Flow control (spray pattern adjustment)
3.	-	Pressure cup (1 litre [1.7 pt] capacity). Maximum pressure 140 psi (9.7 bar, 9.8 kg/cm²).
4.	-	Gun connector
5.	-	Lance nipple connection
6.	-	Flexible lance
7.	-	Rigid directional hook wand (forward cone spray pattern)
8.	-	Flexible nylon 1100mm (43.3in.) lance with 360° spray pattern
9.	-	Rigid 1100mm (43.3in.) lance with 360° spray pattern

When re-treating wax-injected areas which have been disturbed during repairs, it is necessary to use a compressed air spray gun with integral pressure cup and a selection of interchangeable lances.

The following points must be observed during use, according to the attachments fitted:

- Use the rigid or flexible lance attachments with 360° spray dispersal when treating enclosed areas, to ensure maximum coverage.
- Where openings are restricted, use the hook nozzle to provide a more directional spray

1100 mm (43.3in.) Rigid Lance: The nozzle on the rigid lance produces a 360° circular spray pattern combined with a forward-directed spray. Although wax is distributed to all box section surfaces in a single stroke, effective and complete coverage is best achieved in long, straight structures and box section cavities by spraying on both outbound and return strokes of the lance.

The rigid lance also provides the positional accuracy required in shaped sections, by allowing visual assessment.

CAUTION: Do not force the lance into access holes when using this attachment.

1100 mm (43.3in.) Flexible Nylon Lance: This lance is similar in pattern to the rigid version, but provides the additional penetration needed for curved sections or in places where access is difficult. Its main limitation is a lack of positional accuracy inside box sections.

Carry out spraying on the outward stroke of the lance. Withdraw the lance slowly to ensure sufficient coverage. **DO NOT withdraw the lance too quickly.**

Keep the nylon tube of the lance away from the edges of the access hole to eliminate abrasion and extend the life of the tube. Take care to ensure that spraying ceases just before the nozzle emerges from the access hole. To assist this process, apply RED paint to the final 30mm (1.2in.) of the nozzle.

Hook Nozzle on Flexible Lance: The rigid hook produces a highly atomised, forward-directed, fully conical spray pattern having long range and good dispersion characteristics. This combination has good directional capabilities for the treatment of short, narrow sections and may also be used for direct spraying of inner wheel arches etc.

Position the flat area at the end of the lance at 180° to the nozzle spray direction. This will help to guide the spray more accurately when it is concealed in a box section or access hole.

• NOTE: Keep all wax injection/application equipment clean. Use white spirit for this purpose immediately after wax injection operations.

For general spraying move the nozzle in an arc from side to side, to ensure full coverage.

Precautions during Body Repairs and Handling

Take care when handling the vehicle in the workshop. PVC underbody sealers, seam sealers, underbody wax and body panels may be damaged if the vehicle is carelessly lifted.

Always follow the correct lifting, jacking and towing procedures as shown in GENERAL INFORMATION DATA, Information section, paying particular attention to the following points:

Steam Cleaning and Dewaxing

Due to the high temperatures generated by steam cleaning equipment, there is a risk that certain trim items could be damaged and some adhesives and corrosion prevention materials softened or liquified.

Adjust the equipment so that the nozzle temperature does not exceed 90°C (194°F). Take care not to allow the steam jet to dwell on one area, and keep the nozzle at least 300mm (11.8in.) from panel surfaces.

Do NOT remove wax or lacquer from underbody or underbonnet areas during repairs. Should it be necessary to steam clean these areas, apply a new coating of wax or underbody protection as soon as possible.

CORROSION PROTECTION

The following information details the materials that are applied during manufacture for corrosion protection.

Factory Treatments

The Defender is treated with the following anti-corrosion materials in production:

- A PVC based underbody sealer material which is sprayed onto the underfloor, wheel arches and undersill areas.
- An application of cavity wax which is sprayed into enclosed cavities and box sections.
- A final coating of underbody wax to cover the complete underfloor including components but excluding brake discs, exhaust system and propeller shafts.
- A coat of protective lacquer applied to the whole body.
- A coat of protective wax applied to the engine bay and wheel arch areas.

• NOTE: Do not apply wax to engine bay of Td5 models.

In addition to the above measures, all steel parts are zinc-coated both sides.

Underbody Sealer

Underfloor areas and outer sill panels are treated with a Plastisol PVC underbody sealer. This material is not suitable for re-treatment.

When repairing areas of underbody sealer, strip the factory-applied material back to a suitable break point, ensuring that a clean metal surface is exposed and that the edge of the existing material adheres soundly to the panel.

CAUTION: Ensure that suspension units, wheels, tyres, power unit, driveshafts, exhaust and brakes (including all mounting points) are shielded prior to application of fresh underbody sealer

• NOTE: Application of new underbody sealer must be carried out between primer and surfacer paint operations. Areas where seam sealer is used should be re-treated as necessary before application of underbody sealer.

Blanking plugs and grommets in the floor pan (except those used for wax injection) MUST be fitted before underbody sealer application. Heat-fusible plugs which have been disturbed should either be refitted with the aid of a hot air blower or replaced with rubber grommets.

Cavity Wax

Cavity wax is applied to certain box sections The information given on the following pages is intended as a guide and shows the areas to be treated with cavity wax, as well as the access holes used during manufacture.

Underbody Wax

A coat of underbody wax is applied to the entire underbody inboard of the sill vertical flanges, and covers all moving and flexible components EXCEPT for wheels and tyres, brakes and exhaust. The wax is applied over paints and underbody sealers.

CAUTION: Old underbody wax must be completely removed from a zone extending at least 200 mm (7.9 in) beyond the area where new underbody sealer is to be applied.

The underbody wax must be reinstated following all repairs affecting floor panels.

Engine Bay Wax

Reinstate protective engine bay wax disturbed during repairs using the approved material.

Wheel Arch Wax

Reinstate protective wheel arch wax disturbed during repairs using the approved material.

Stone Chip Resistant Paint/Primer

Re-treat all areas protected with factory-applied anti-chip primer with suitable approved material in repair.

Inspections during Maintenance Servicing

It is a requirement of the Land Rover Corrosion Warranty that the vehicle body is checked for corrosion by an authorised Land Rover dealer at least once a year, to ensure that the factory-applied protection remains effective.

Service Job Sheets include the following operations to check bodywork for corrosion:

• NOTE: Wash the vehicle and ensure that it is free from deposits prior to inspection. It is part of the owner's responsibility to ensure that the vehicle is kept free of accumulations of mud which could accelerate the onset of corrosion. The Dealer MUST wash the vehicle prior to inspection of bodywork if the customer has offered it in a dirty condition, and pay special attention to areas where access is difficult.

• NOTE: The checks described above are intended to be visual only. It is not intended that the operator should remove trim panels, finishers, rubbing strips or sound deadening materials when checking the vehicle for corrosion and paint damage.

With the vehicle on a lift, and using an inspection or spot lamp, visually check for the following:

• NOTE: The presence of small blisters in PVC underbody sealer is acceptable, providing they do not expose bare metal.

Special attention must be paid to signs of damage caused to panels or corrosion material by incorrect jack positioning.

It is essential to follow the correct jacking and lifting procedures. See GENERAL INFORMATION DATA, Information section.

With the vehicle lowered, visually check for evidence of damage and corrosion on all painted areas, in particular the following:

Where bodywork damage or evidence of corrosion is found during inspection, rectify this as soon as is practicable, both to minimise the extent of the damage and to ensure the long term effectiveness of the factory-applied corrosion protection treatment. Where the cost of rectification work is the owner's responsibility, the Dealer must advise the owner

and endorse the relevant documentation accordingly.

Where corrosion has become evident and is emanating from beneath a removable component (e.g. trim panel, window glass, seat etc.), remove the component as required to permit effective rectification.

Underbody Protection Repairs

When body repairs are carried out, always ensure that full sealing and corrosion protection treatments are restored. This applies both to the damaged area, and also to areas where protection has been indirectly impaired as a result of accident damage or repair operations.

Prior to straightening out or panel beating, remove all corrosion protection material in the damaged area. This applies in particular to panels coated with wax, PVC underbody sealer, sound deadening pads etc.

WARNING: DO NOT use oxy-acetylene gas equipment to remove corrosion prevention materials. Large amounts of fumes and gases are liberated by these materials when they burn.

Equipment for the removal of tough anti-corrosion sealers offers varying degrees of speed and effectiveness. The compressed air-operated scraper (NOT an air chisel) offers a relatively quiet mechanical method of removal using an extremely rapid reciprocating action. During use, direct the operating end of the tool along the work surface.

The most common method is by the use of a hot air blower with integral scraper.

CAUTION: High temperatures can be generated with this equipment which may cause fumes. Always exercise care in its use.

Another tool, and one of the most efficient methods, is the rapid-cutting 'hot knife'. This tool uses a wide blade and is quick and versatile, able to be used easily in profiled sections where access is otherwise awkward.

Use the following procedure when repairing underbody coatings:

Underbody Wax

• NOTE: Where repairs include the application of finish paint coats in the areas requiring underbody wax, paint operations must be carried out BEFORE wax application.

After refitting mechanical components, including hoses, pipes and small fixtures, mask off the brake discs and apply a coat of approved underbody wax.

Underbonnet Wax

Where repairs have involved replacement of engine bay panels, treat the entire engine compartment including all components, clips and small fixtures with an approved underbonnet lacquer or wax.

Proprietary Anti-Corrosion Treatments

The application of proprietary anti-corrosion treatments in addition to the factory-applied treatment could invalidate the Corrosion Warranty and should be discouraged. This does not apply to approved, compatible, preservative waxes which may be applied on top of existing coatings.

Fitting Approved Accessories

When fitting accessories it is important that the vehicle's corrosion protection is not affected, either by breaking the protective coating or by introducing a moisture trap.

DO NOT screw self-tapping screws directly into the body panel but fit plastic inserts first. Protect the edges of holes drilled into panels, chassis members and other body parts with a suitable zinc rich or acid etch primer, followed by a protective wax coating brushed onto the surrounding area.

DO NOT affix unpainted metal surfaces of any accessory directly to the vehicle bodywork unless they are suitably protected. Where metal faces are bolted together always interpose a suitable interface material such as weldable zinc rich primer, extruded strip or zinc tape.

CAVITY WAX

Box sections treated with cavity wax are shown in this section. Repairs affecting these areas must include re-treatment with an approved cavity wax, using the access points illustrated. In addition, all interior surfaces which have been disturbed during repairs must be wax injected whether they have been treated in production or not. This includes all box members, cavities, door interiors etc. It is permissible to drill extra holes for access where necessary, provided these are not positioned in load-bearing members. Ensure that such holes are treated with a suitable zinc rich primer, brushed with wax and then sealed with a rubber grommet.

Prior to wax injection, ensure that the cavity to be treated is free from any contamination or foreign matter. Where necessary, clear out any debris using a compressed air supply.

Carry out wax injection after final paint operations.

During application, ensure that the wax covers all flange and seam areas and that it is applied to all repaired areas of both new and existing panels.

• NOTE: Apply cavity wax AFTER the final paint process and BEFORE refitting of any trim components.

It should also be noted that new panel assemblies and body shells are supplied without wax injection treatment which must be carried out after repairs.

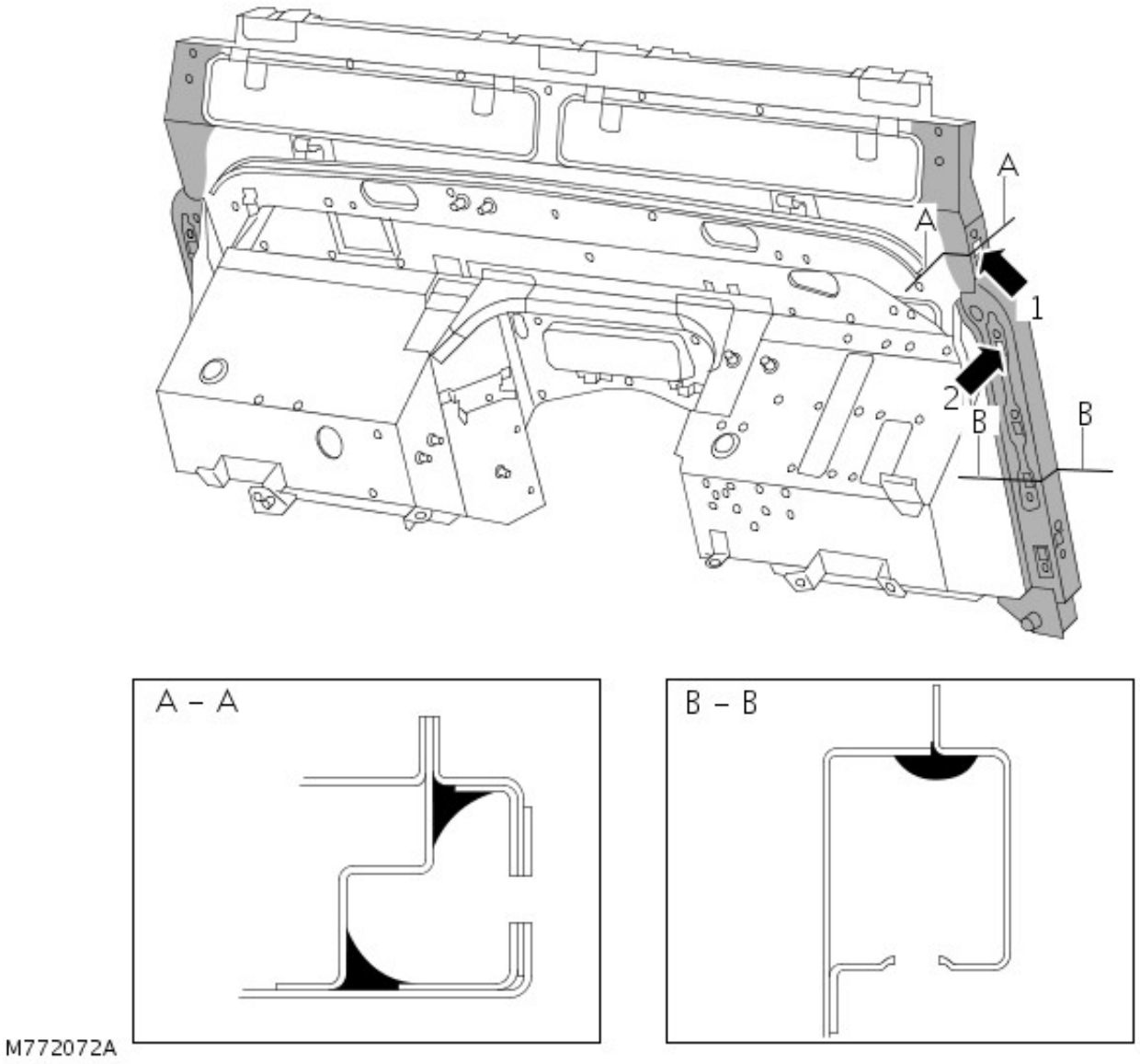
Effective cavity wax protection is vital. Always observe the following points:

- Complete all finish paint operations before wax application.
- Clean body panel areas and blow clean cavities if necessary, before treatment.
- Maintain a temperature of 18°C (64°F) during application and drying.
- Check the spray pattern of injection equipment.
- Mask off all areas not to be wax coated and which could be contaminated by wax overspray.
- Remove body fixings, such as seat belt retractors, if contamination is at all likely.
- Move door glasses to fully closed position before treating door interiors.
- Treat body areas normally covered by trim before refitting items.
- Check that body and door drain holes are clear after the protective wax has dried.
- Keep all equipment clean, especially wax injection nozzles.

The following Illustrations show the treatment areas and Injection holes for Cavity Wax application.

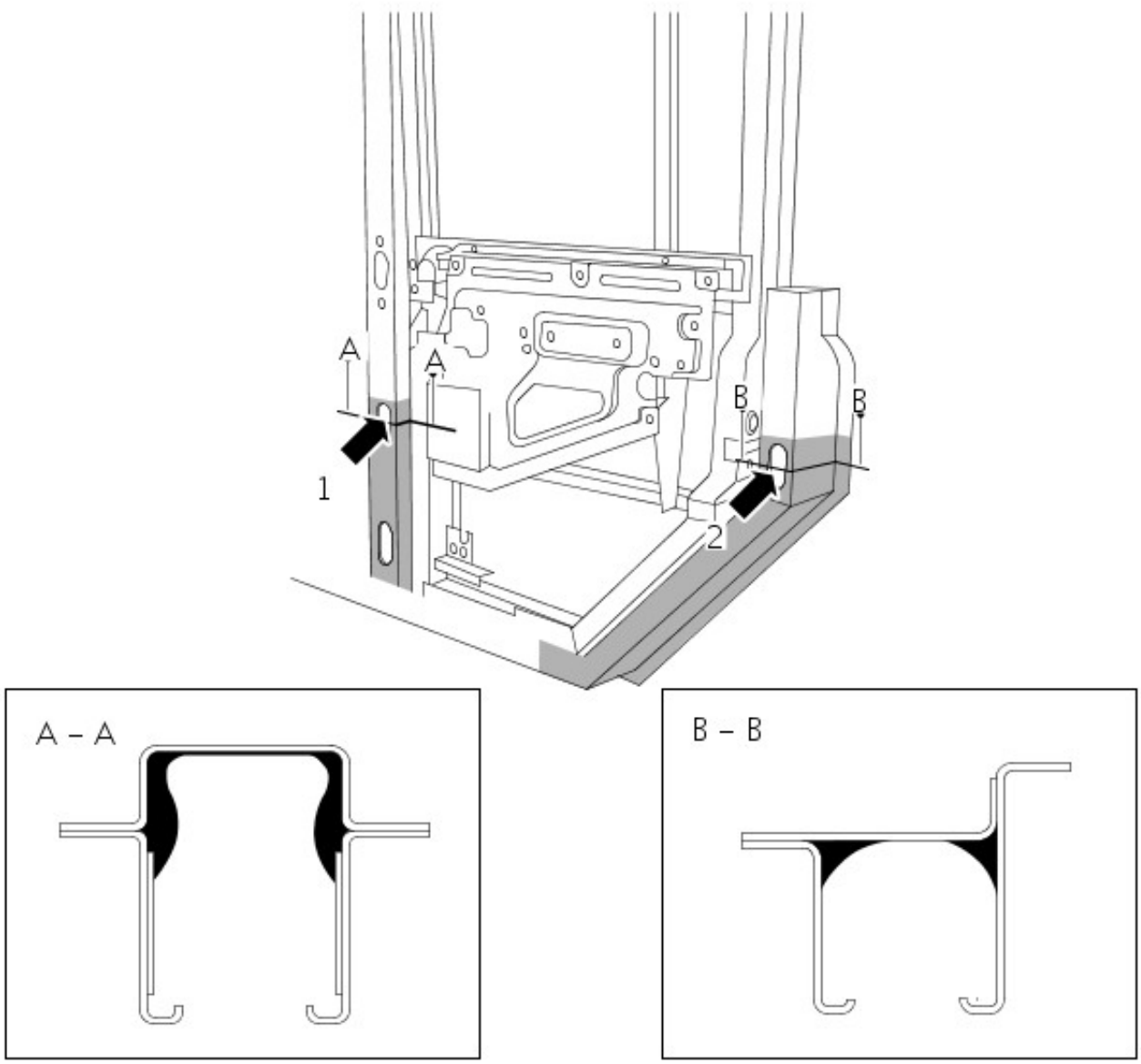
All areas symmetrically opposite to those shown are also treated.

Bulkhead assembly



Section A-A and B-B show application areas of cavity wax. Arrows 1 and 2 show application holes.

'B/C' post assembly

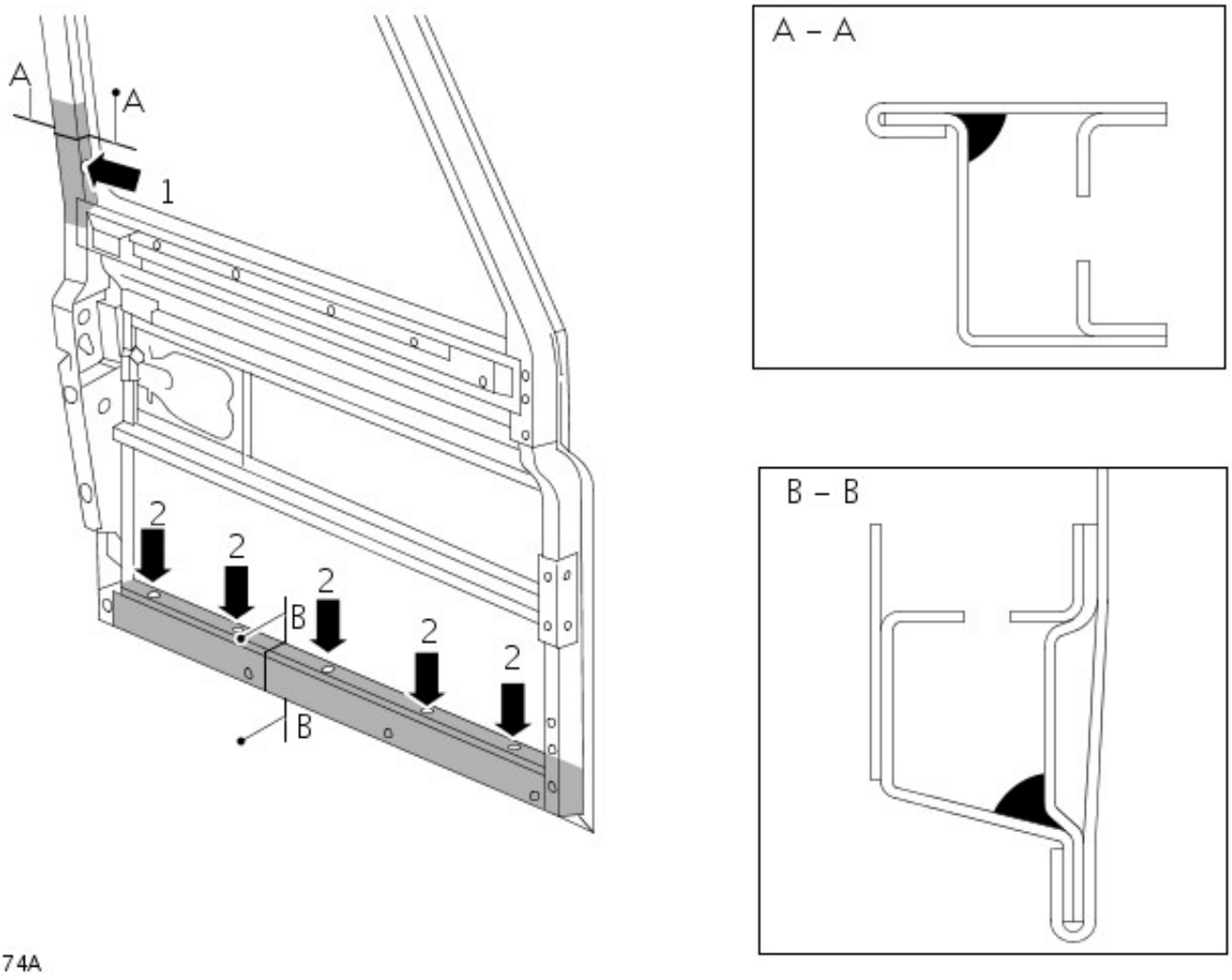


M772073A

Section A-A shows application area of cavity wax for the 'B/C' post. Arrow 1 shows application hole.

Section B-B shows application area of cavity wax for the 'D' post. Arrow 2 shows application hole.

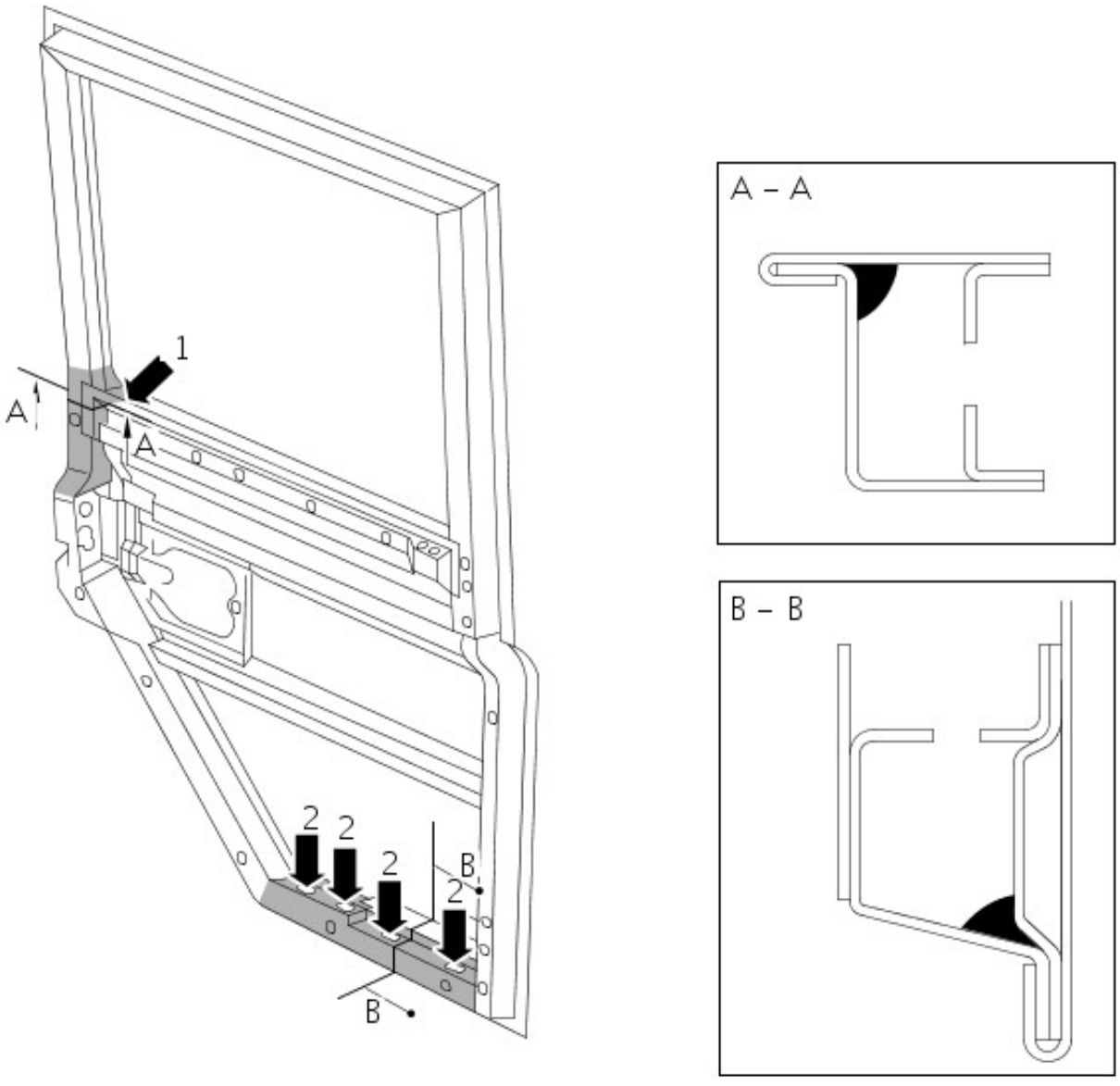
Front door



M772074A

Section A-A and B-B show application areas of cavity wax for the front door. Arrows 1 and 2 show the application holes.

Rear door



Section A-A and B-B show application areas of cavity wax for the rear door. Arrows 1 and 2 show the application holes.

SEALANTS AND ADHESIVES

Structural Adhesive

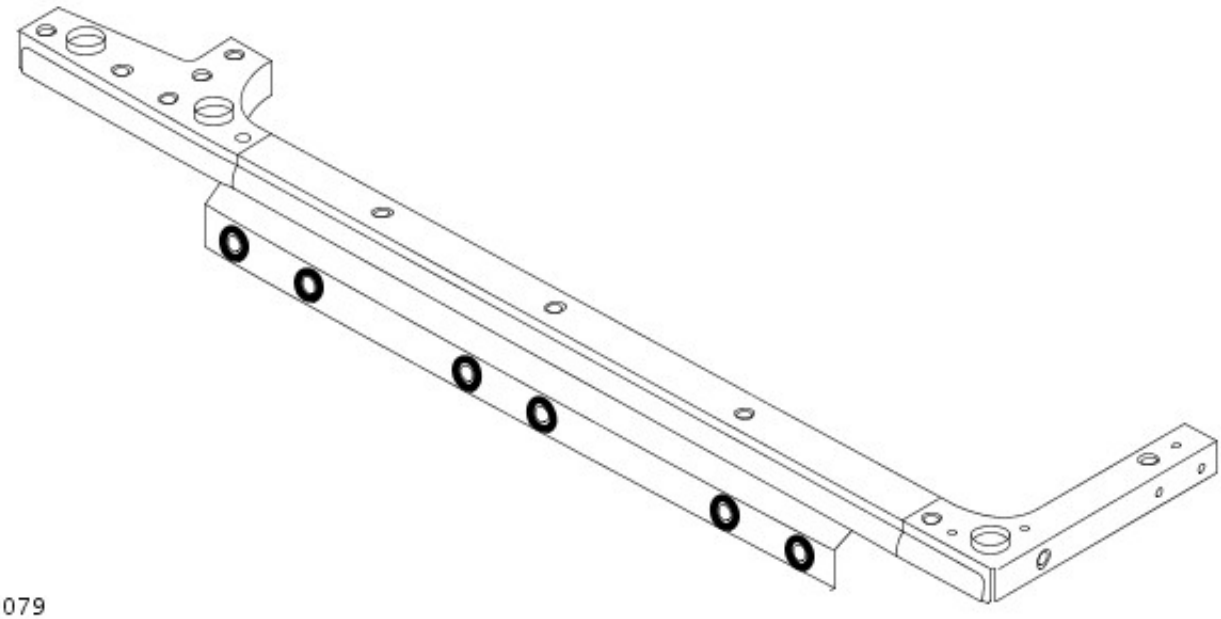
Metal-to-metal adhesive is applied to critical joint areas during factory assembly. The material used is a high-temperature, heat cured, nitrile phenolic which serves both to bond two metal surfaces and also to seal the joint against ingress of dust, water, petrol and fumes. This material is not suited for service use, and should be substituted in repair using a suitable medium strength adhesive.

When separating a joint treated with metal-to-metal adhesive, to avoid distortion it is recommended that the joint be gently heated until the bond weakens sufficiently to permit panel separation.

• NOTE: DO NOT carry out MIG welding on a joint area which has been treated with metal-to-metal adhesive until all traces of adhesive have been removed.

The following Illustrations show the treatment areas for Structural Adhesive. All areas symmetrically opposite to those shown are also treated.

Body side capping



Structural adhesive applied around body side lower fixing holes

Seam sealers

A heat cured, PVC Plastisol sealer is applied to joint areas during factory assembly. This material is not suitable for service use.

Carry out seam sealing after the application of primer and before the surfacer and final paint coats. Ensure that surfaces are first cleaned of all grease and oil. Apply the sealer material to the joint as a bead, either by hand or using an applicator gun. Where necessary, brush sealer well into the joint and wipe smooth using a cloth soaked with solvent such as Shell SBP3. This will ensure an acceptable cosmetic finish.

Apply sealer to ALL accessible joints following repair work. Be aware that damage to a vehicle can often result in deflection to those areas of the body which are remote from the impact. The sealers in these areas can therefore be disturbed by subsequent straightening and repair operations. Check joints in the vicinity of the area undergoing repair for evidence of cracked sealer, clean them out as required and re-treat them with fresh sealer using the following procedure:

Where joints are inaccessible following the reassembly or fitment of components, ensure that a paste-type sealer is applied to such joints. Certain seams also become inaccessible after the completion of panel repairs. In such instances the paint process should be carried out and sealers applied before final assembly.

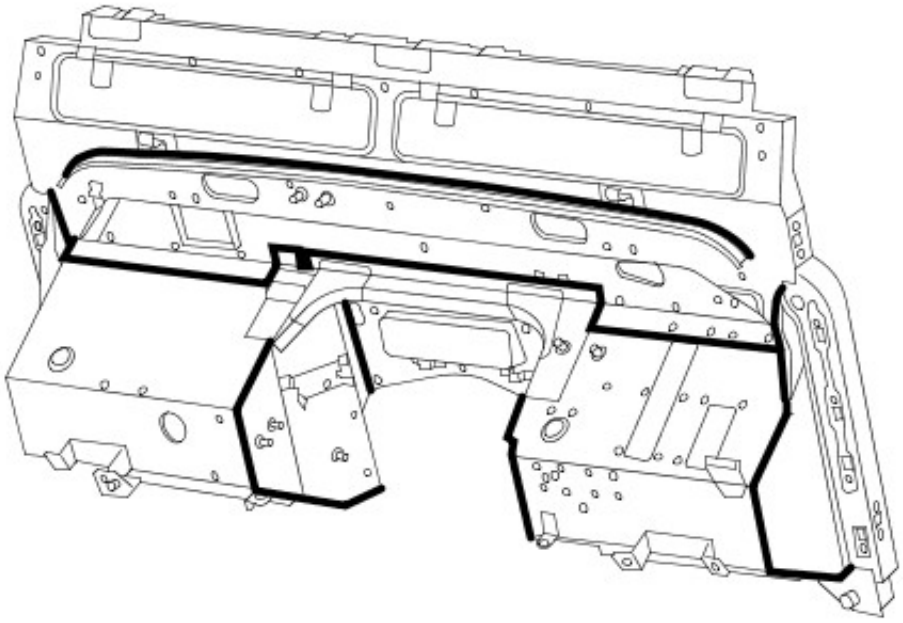
Provided access is adequate, apply the sealer to both sides of the repair joint. Where access is limited to one side only (e.g. box sections), inject the affected box member with cavity wax.

CAUTION: ALWAYS deploy an extractor unit to remove toxic fumes when using oxy-acetylene equipment to remove panels treated with wax and sealers.

The following Illustrations show the treatment areas for Seam Sealing.

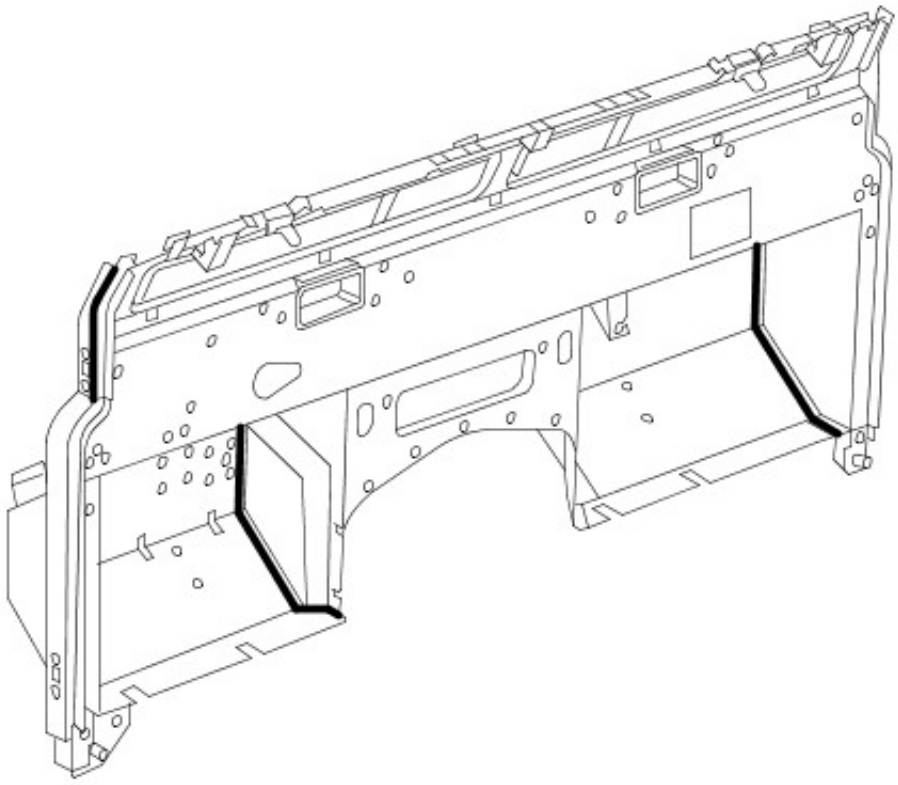
All areas symmetrically opposite to those shown are also treated.

Seam sealing on bulkhead assembly - front view



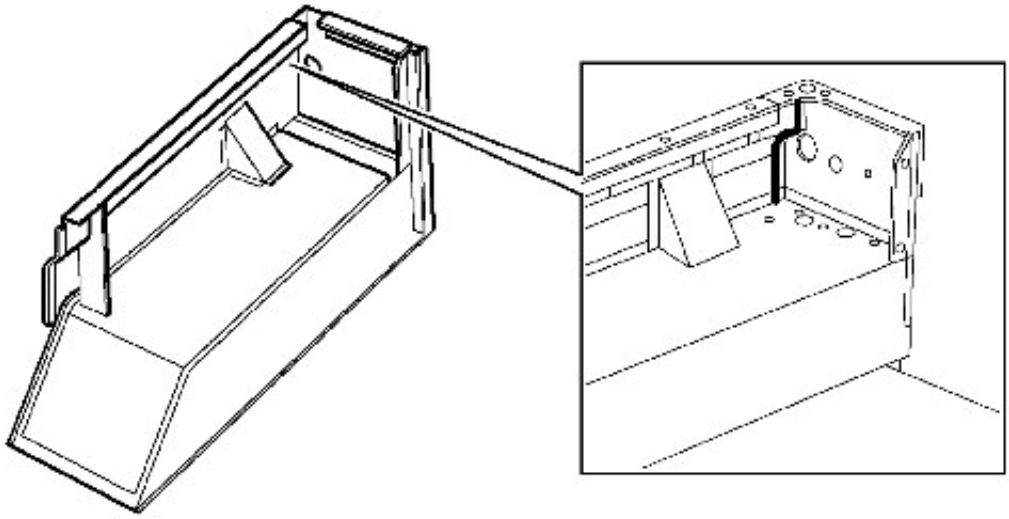
M772082A

Seam sealing on bulkhead assembly - rear view



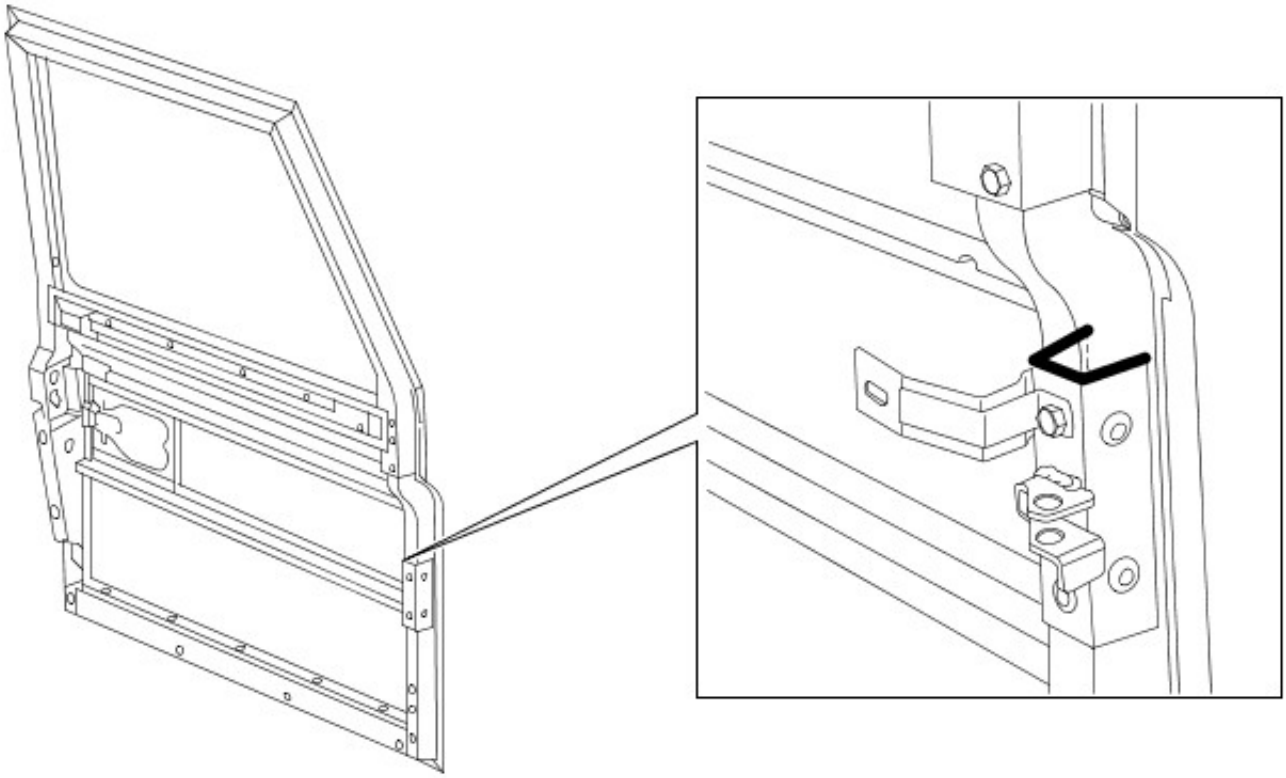
M772083A

Seam sealer on body side assembly



M772084A

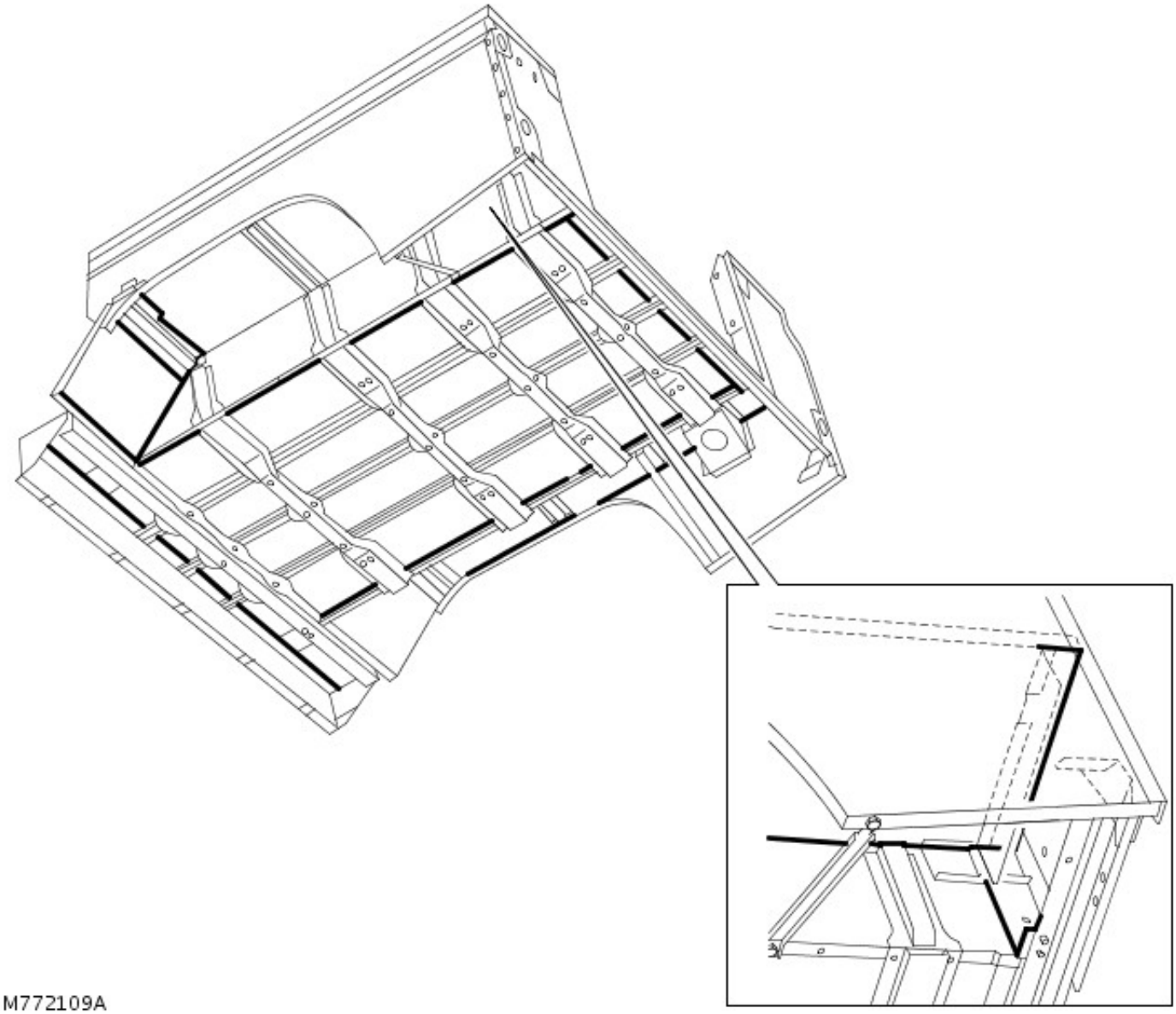
Seam sealer on front door



M772090A

• NOTE: Seam sealer to be wiped after application for cosmetic purposes.

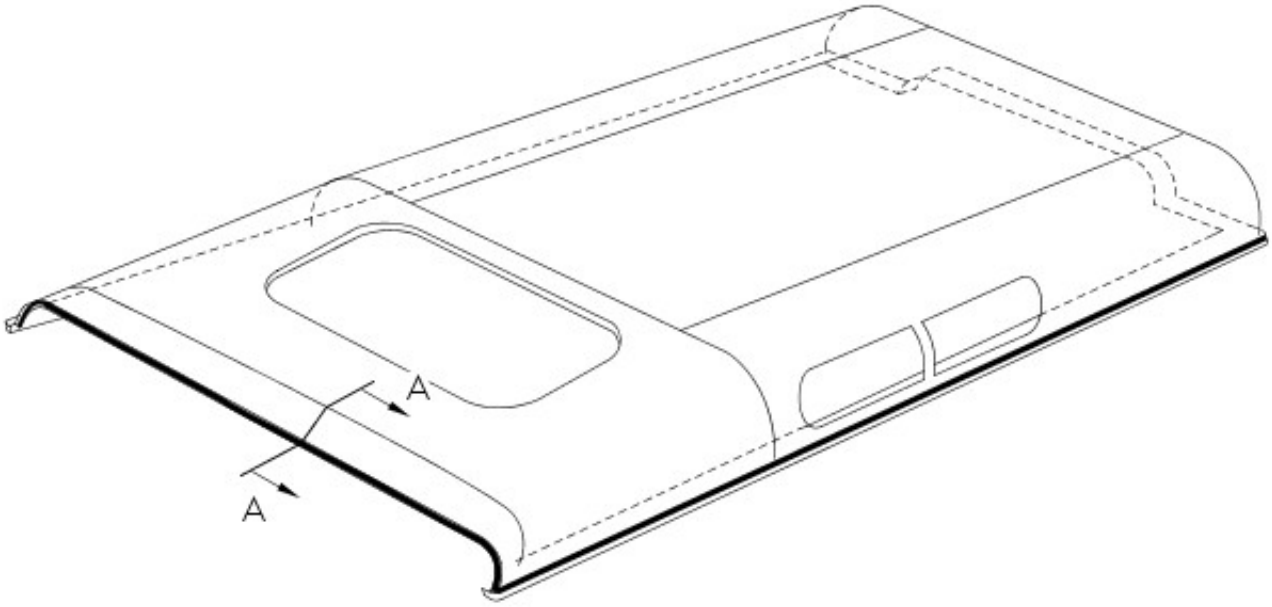
Seam sealer on rear end assembly

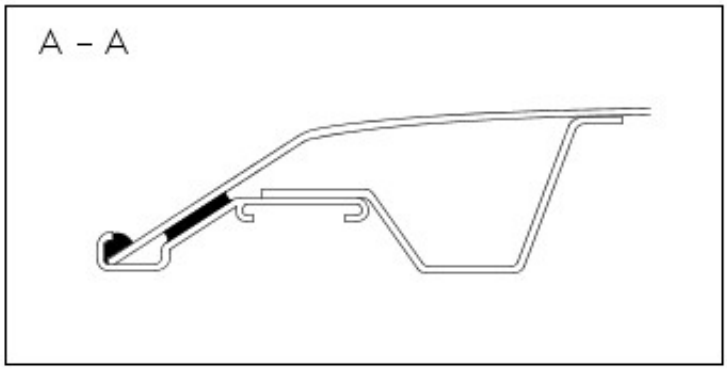


M772109A

CAUTION: Do not block drain holes when applying seam sealer.

Seam sealer on roof assembly



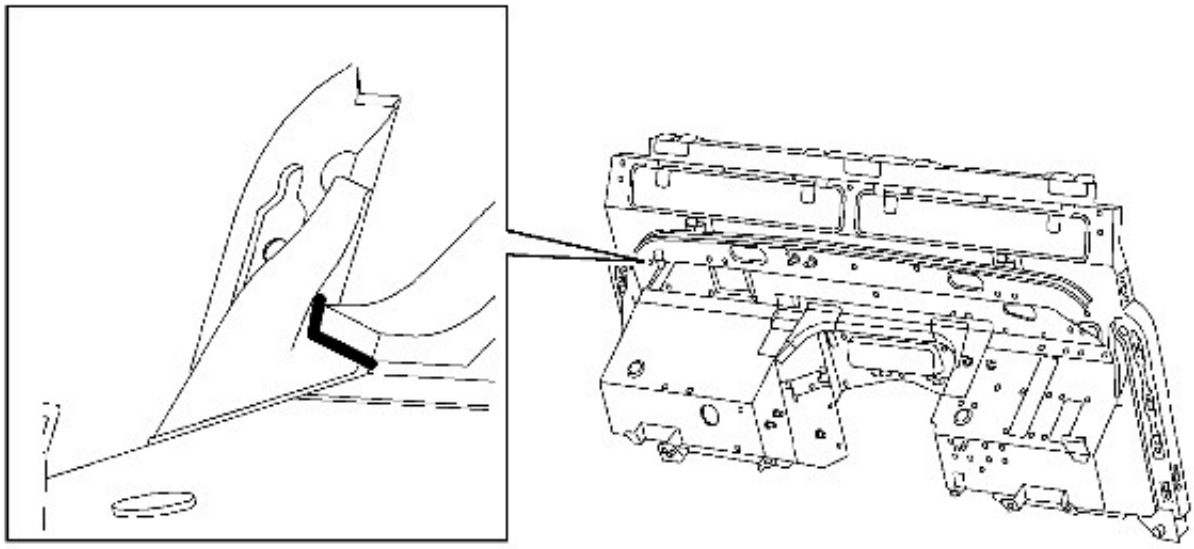


M772091A

Putty application areas

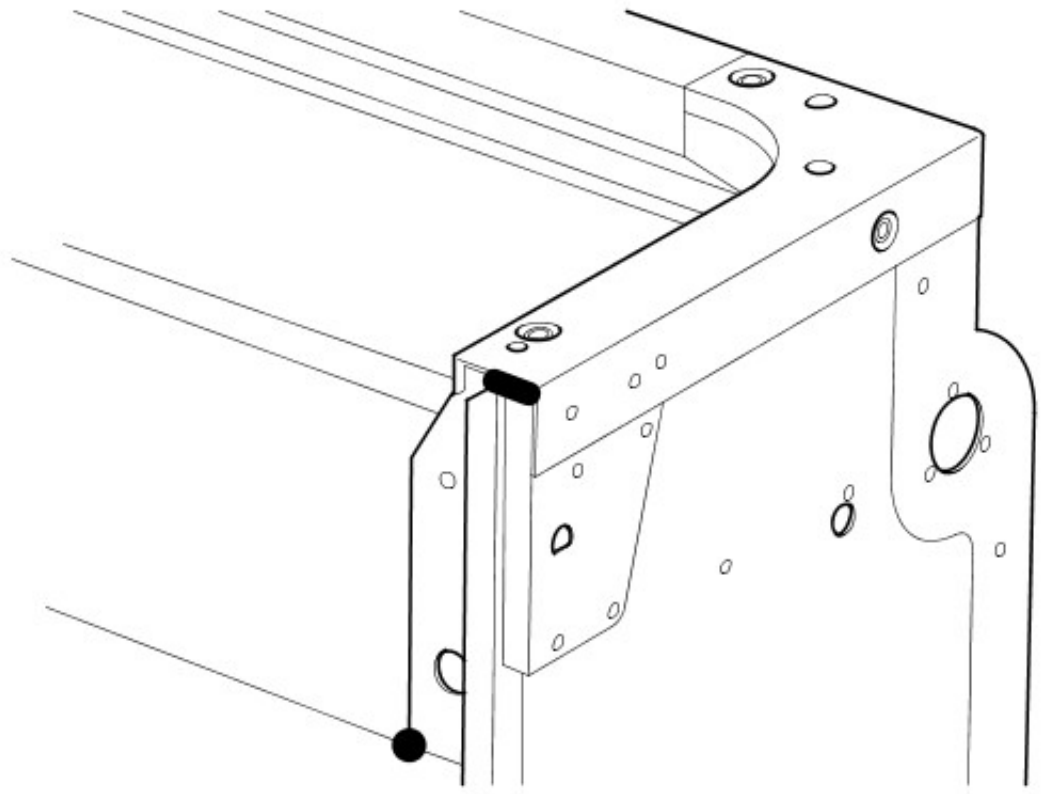
The following Illustrations show the treatment areas for Putty application. All areas symmetrically opposite to those shown are also treated.

Putty location on bulkhead assembly



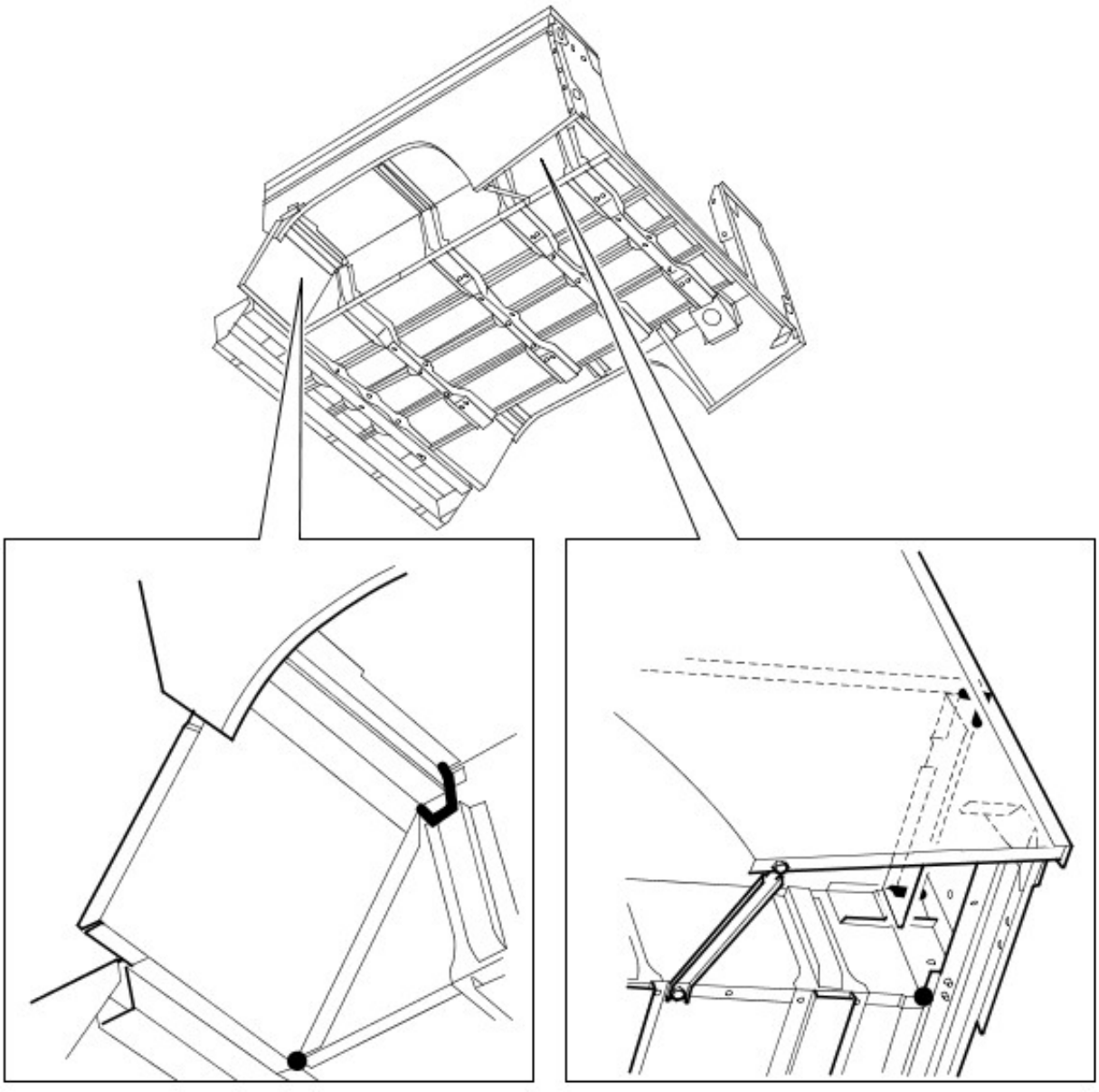
M772086A

Putty location on rear end



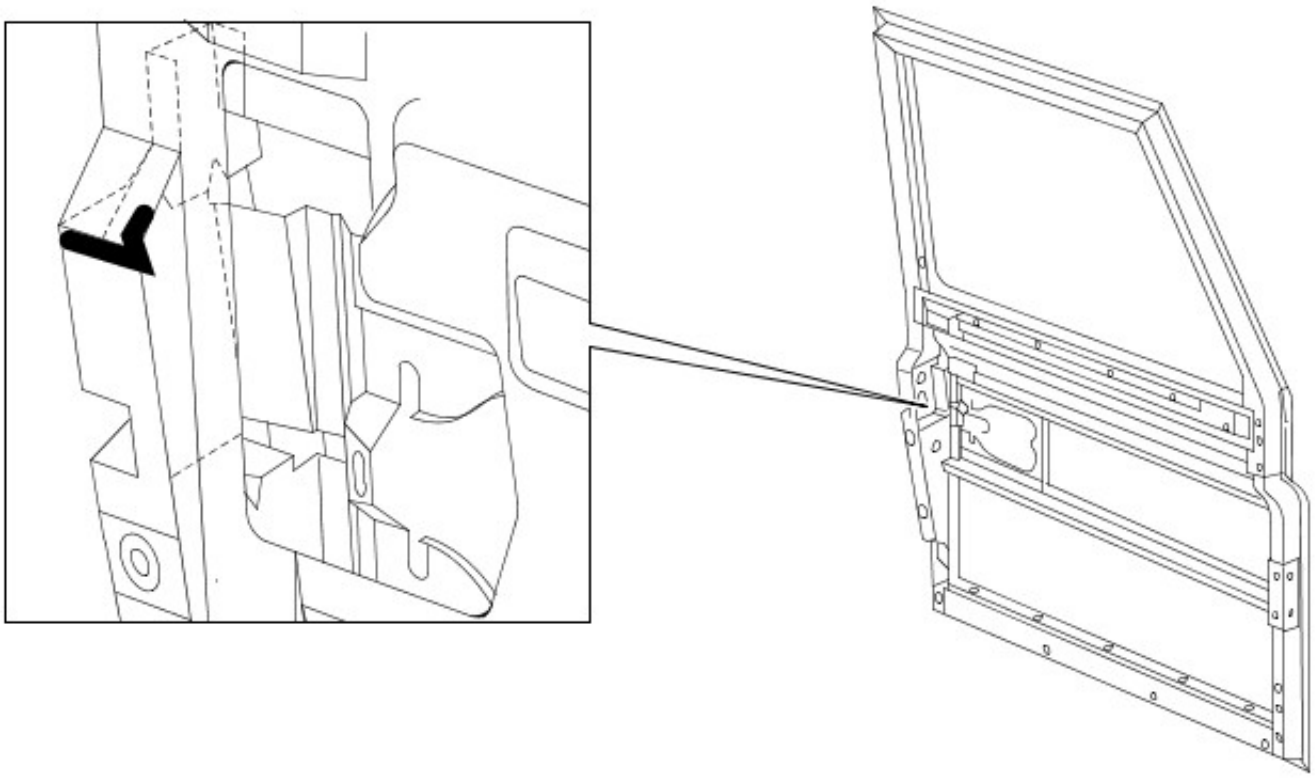
M772087A

Putty location on underside of vehicle



M772088A

Putty location on front door

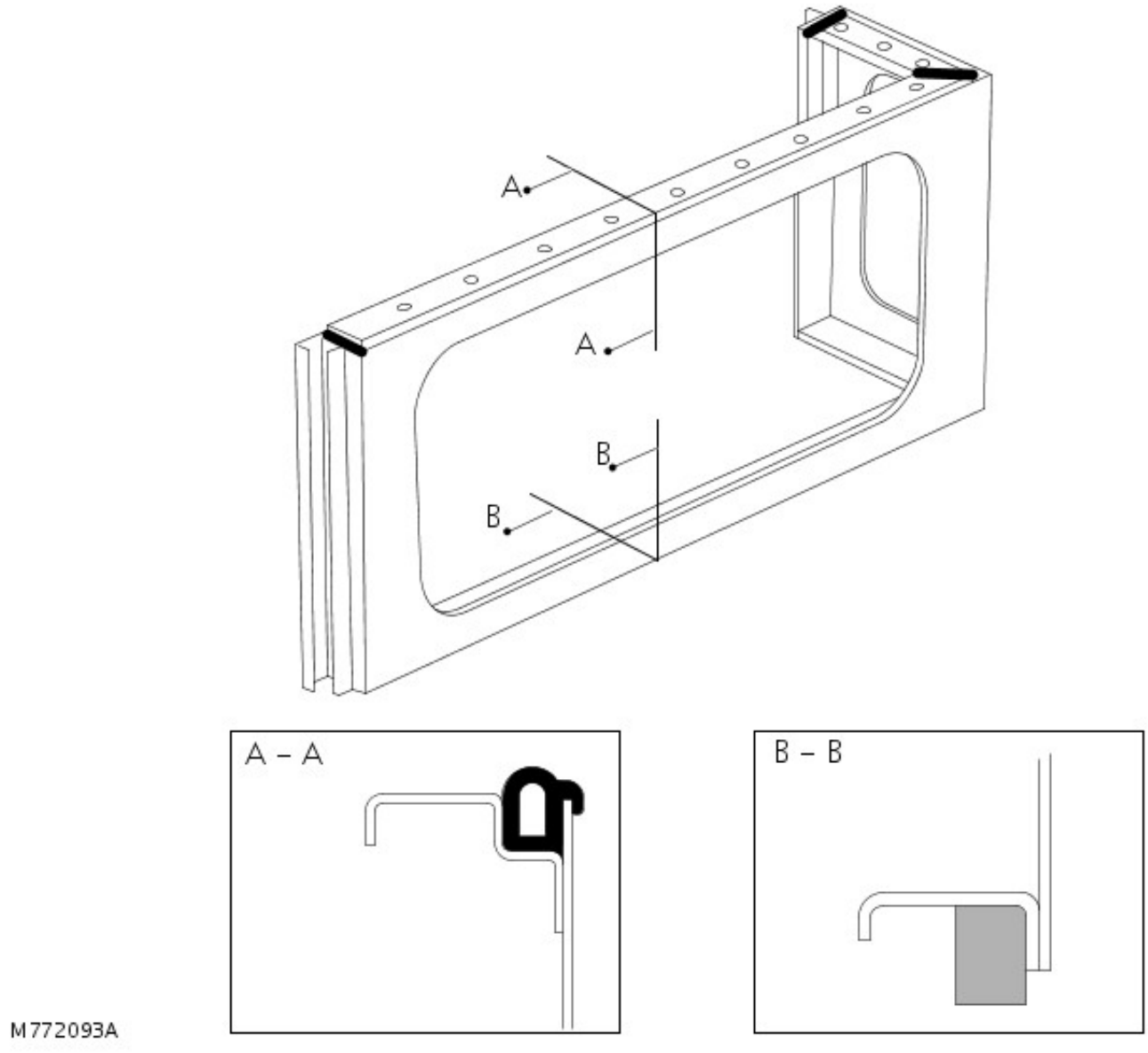


M772089A

Foam/rubber seal application areas

The following Illustrations show the location of foam/rubber seals. All areas All areas symmetrically opposite to those shown are also treated.

Body side rear

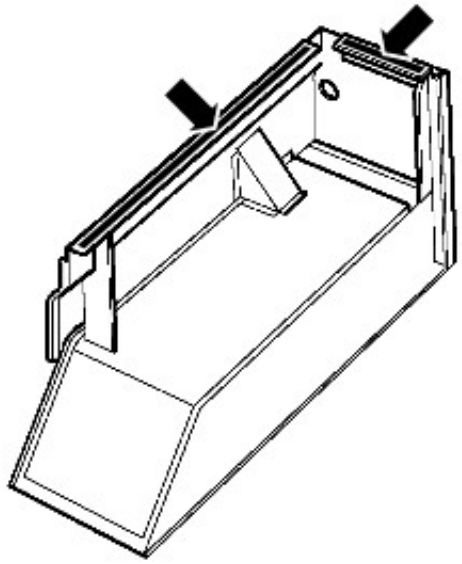


Section A-A shows a rubber seal in position on the body side rear upper assembly.

CAUTION: Ensure rubber seal is correctly seated into channel.

Section B-B shows a foam seal located on the bottom edge of the body side rear upper assembly. It is fixed to the panel using double sided tape.

Body side lower



M772080A

CAUTION: Ensure seals are fitted before refitting assembly.

The arrows indicate the position of two foam seals.

Body Repairs - Water Leaks - Water Leaks

Description and Operation

WATER LEAKS

Sealing charts in the Corrosion Protection section show those areas of the bodyshell most likely to be affected by accident damage and water leaks, and which could therefore require re-treatment in repair. They do not show those joint areas which only apply to factory assembly operations and which are unlikely to be disturbed in service (e.g. centre tunnel), or where the damage would be so severe that the entire bodyshell would normally be written off.

When water leakage occurs, always adopt a logical approach to the problem using a combination of skill, experience and intuition. Do not attempt to reach a conclusion based only on visual evidence, such as assuming that a leak emanates from the windscreen because the footwell is wet. It will often be found that the source of the leak is elsewhere. The correct procedure will increase the chance of locating a leak, however obscure it may seem.

Tools and Equipment

The following tools and equipment are recommended for detection and rectification of water leaks:

- Garden sprayer (hand-operated).
- Wet/dry vacuum cleaner.
- Dry absorbent cloths.
- Battery torch.
- Small mirror.
- Weatherstrip locating tool.
- Trim panel remover.
- Small wooden or plastic wedges.
- Dry compressed air supply.
- Hot air blower.
- Sealer applicators.
- Ultrasonic leak detector.

During leak detection, the vehicle should be considered in three basic sections:

- The front interior space;
- The rear passenger space, where applicable;
- The rear loadspace or boot.

Testing

From the information supplied by the customer it should be possible for the bodyshop operator to locate the starting point from which the leak may be detected. After the area of the leak has been identified, find the actual point of entry into the vehicle. A simple and effective means initially is an ordinary garden spray with provision for pressure and jet adjustment. This will allow water to be directed in a jet or turned into a fine spray. Use a mirror and a battery-powered torch (NOT a mains voltage inspection lamp) to see into dark corners.

The sequence of testing is particularly important. Start at the lowest point and work slowly upwards, to avoid testing in one area while masking the leak in another. For example, if testing started at the level of the windscreen, any water cascading into the plenum chamber could leak through a bulkhead grommet and into the footwells. Even at this point it could still be wrongly assumed that the windscreen seal was at fault.

Another important part of identifying a water leak is by visual examination of door aperture seals, grommets and weatherstrips for damage, deterioration or misalignment, together with the fit of the door itself against the seals.

Sealing

When the point of the leak has been detected, proceed to rectify it using the following procedure:

- Renew all door aperture seals and weatherstrips which have suffered damage, misalignment or deterioration.
- Check all body seals to ensure that they are correctly located on their mounting flanges/faces using a locating tool if necessary.
- Dry out body seams to be treated using compressed air and/or a hot air blower as necessary.
- Apply sealant on the outside of the joint wherever possible to ensure the exclusion of water.
- When rectifying leaks between a screen glass and its weatherstrip (or in the case of direct glazing, between the glass and bodywork), avoid removing the glass if possible. Apply the approved material either at the glass to weatherstrip or glass to body.

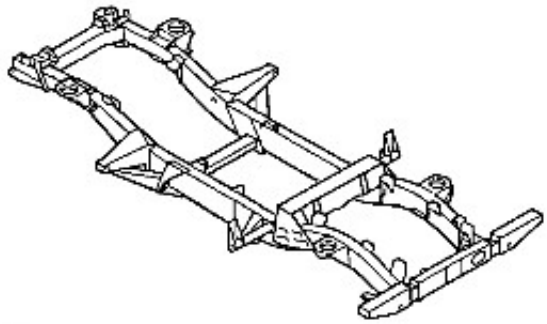
Body Repairs - Vehicle Specific Information and Tolerance Checks - Body and Frame

Description and Operation

CHASSIS AND BODY

Chassis

The chassis on all Defender variants are of the box section, ladder type construction, manufactured from 2 mm (14swg) steel and treated with zinc phosphate, cathodic electro coated, followed by waxing in the rear cross member.

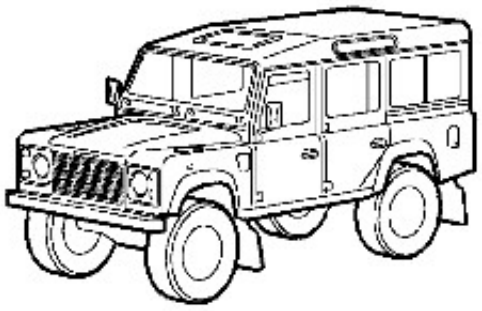


J6348

Outriggers and angled brackets welded to the chassis support suspension and axle components and are also used as body mounting points. A detachable box section cross member, located between the two chassis longitudinals is fitted to facilitate main gearbox and transfer box assembly removal.

Should chassis damage occur, a comprehensive range of components are available, including body support outriggers, cross members and radius arm mounting brackets. ALWAYS fit genuine parts that are fully guaranteed and to original equipment specification, fitted with Land Rover's BS 5135 welding standard.

Body



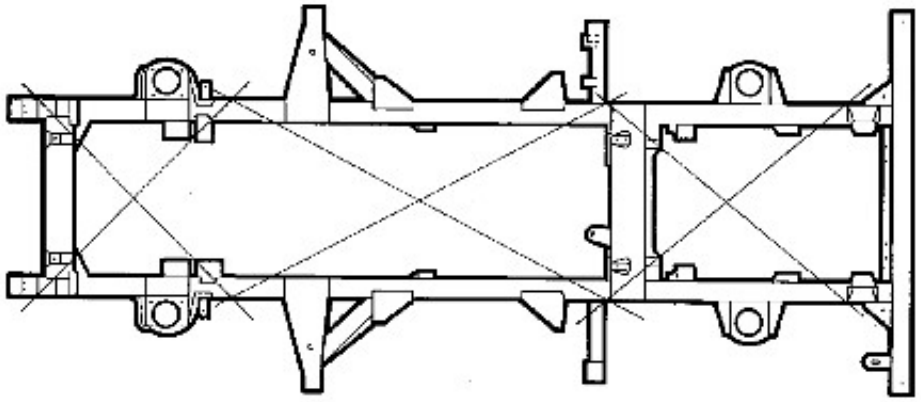
M764325

All body panels, with the exception of the fascia bulkhead, are manufactured from aluminium alloy. Galvanized steel is used for the front wheel arches to give optimum protection. Most panels are also treated with zinc phosphate and cathodic electro coated with polyester surfacer, and are bolted to the welded chassis.

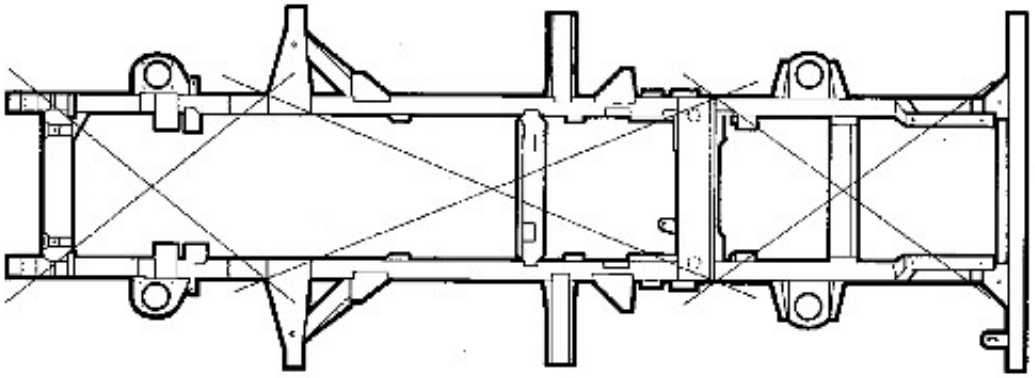
CHASSIS FRAME ALIGNMENT

With the vehicle assembled, a check for chassis squareness can be made as follows:

- **1.** Place the vehicle on a level floor.
- **2.** Mark measuring points at approximately the locations shown in LR4412M ensuring that the marks are exactly opposite on each side of the chassis frame.
- **3.** Hold a plumb line against each of the measuring points in turn and mark the floor directly beneath the plumb-bob.
- **4.**Move the vehicle and measure diagonally between the marks made on the floor, if the chassis is square the diagonals between the related measuring points should agree within 9,50 mm.
- **5.**Chassis frame dimensional checks can be made, with the vehicle upper structure removed, referring to the applicable illustration and associated key.



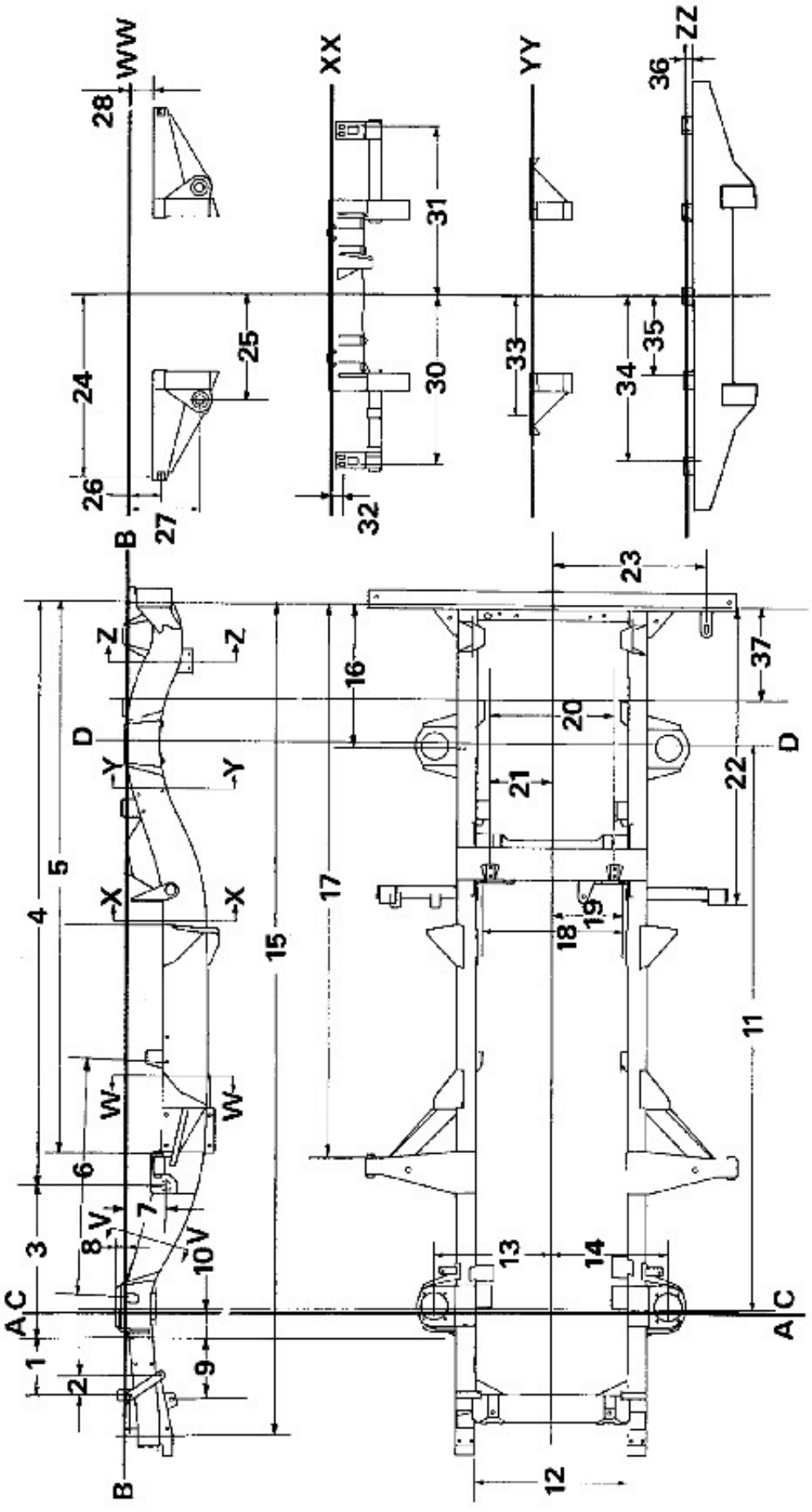
LAND ROVER 90



LAND ROVER 110

LR4412M

90 Chassis



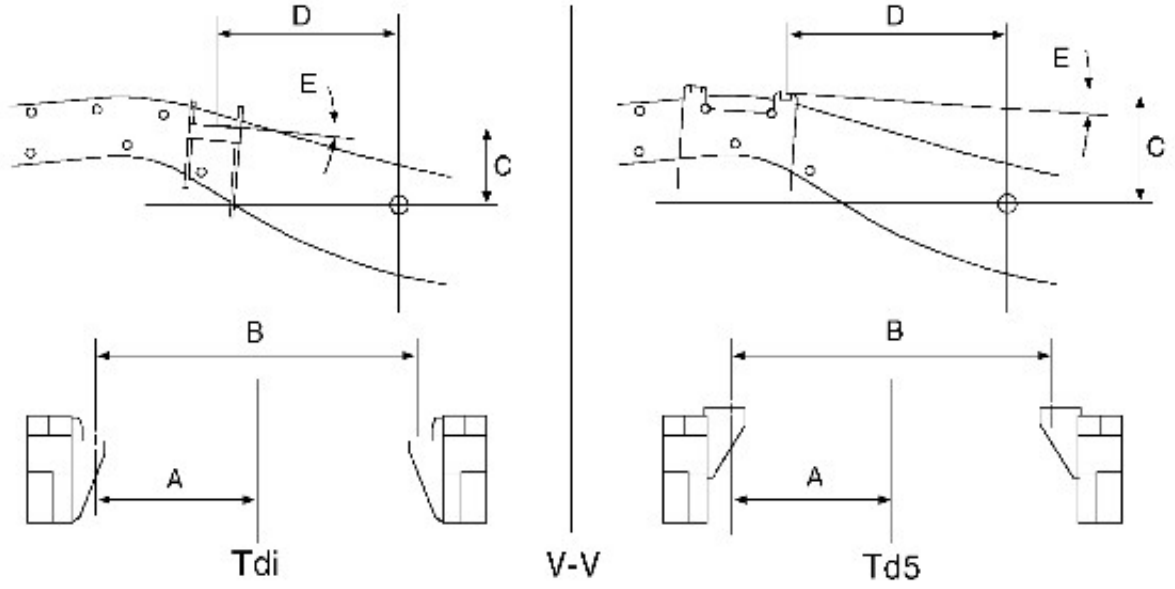
Chassis alignment dimensions

No./Letter	Dimension
A	Front datum
B	Chassis Datum
C	Front axle centre line

D	Rear axle centre line
1.	239,0 - 236,5 mm
2.	82,0 - 79,5 mm
3.	633 mm
4.	2420,6 - 2418,6 mm
5.	2306,4 - 2305,4 mm
6.	981,2 - 978,7 mm
7.	182,7 mm
8.	41,5 - 37,0 mm
9.	252 - 250 mm
10.	110 mm
11.	2360mm - Wheelbase
12.	636 - 634 mm
13.	488 - 482 mm
14.	488 - 482 mm
15.	3431,1 - 3426,1 mm
16.	588,3 - 586,3 mm
17.	2313,8 - 2311,8 mm
18.	590,5 mm
19.	295,25 mm
20.	519,30 - 517,30 mm
21.	259,80 - 258,50 mm
22.	1242,6 - 1240,6 mm
23.	642,5 - 639,5 mm
24.	750,9 mm
25.	439,5 - 436,5 mm
26.	136,5 mm
27.	299,5 - 295,5 mm
28.	103 - 100 mm
29.	131,5 - 126,5 mm
30.	705,5 - 704,5 mm
31.	705,5 - 704,5 mm
32.	42,2 - 40,2 mm
33.	491 - 486 mm
34.	594,2 - 593,4 mm
35.	283,0 - 282,2 mm
36.	32,25 - 31,25 mm
37.	397 - 395 mm

Engine mounting dimensions - section V-V

- NOTE: The engine mounting bracket dimensions are applicable to all models



M772129

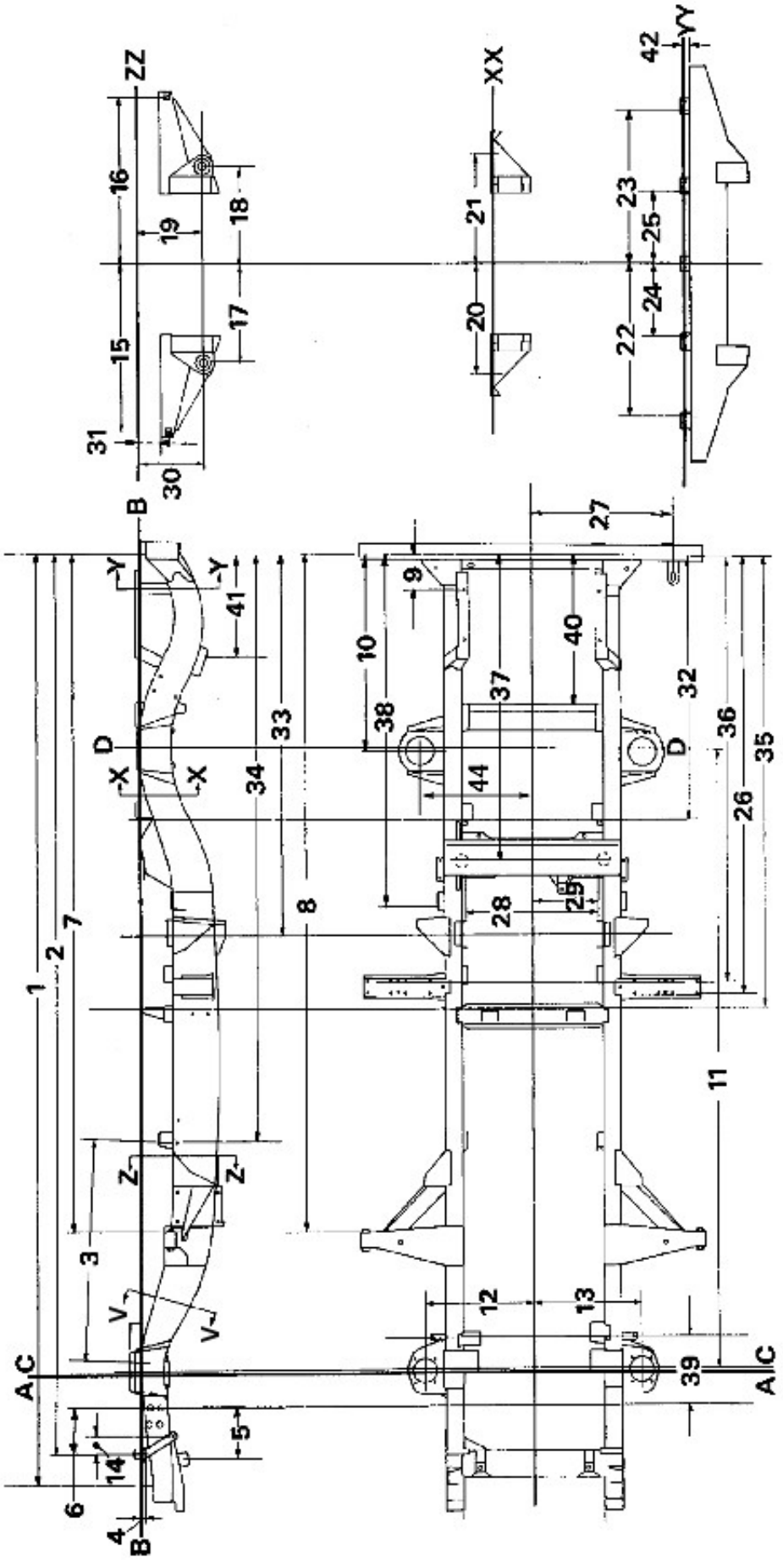
Tdi dimensions

Dimension	value
A	276.5 mm
B	553 mm
C	127.9 mm
D	317.4 mm
E	4 °

Td5 dimensions

Dimension	value
A	273.2 mm
B	546.5 mm
C	187.8 mm
D	347.3 mm
E	4 °

110 Chassis



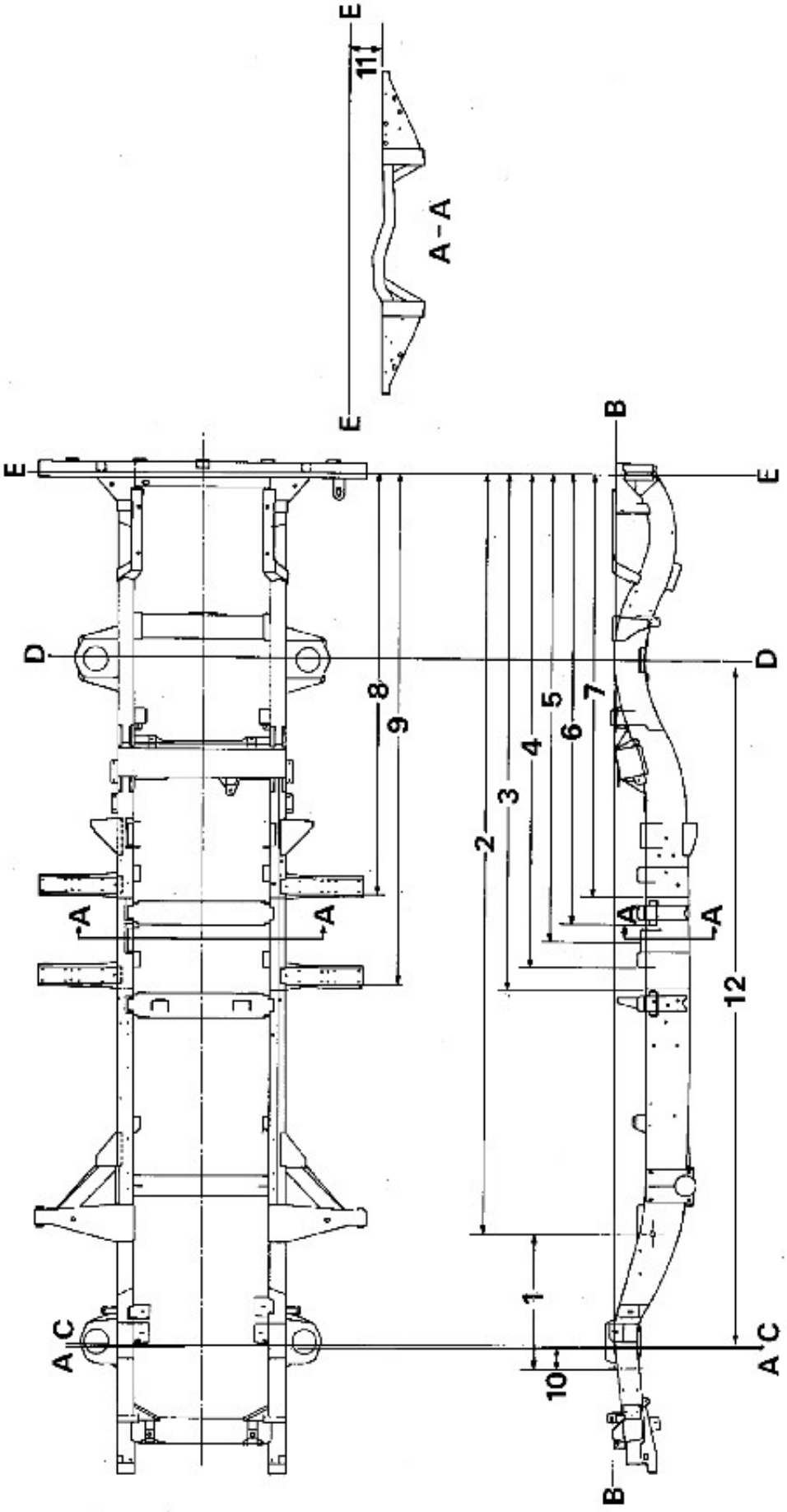
Chassis alignment dimensions

No./Letter	Dimension
A	Front datum
B	Chassis Datum
C	Front axle centre line

D	Rear axle centre line
1.	4148 - 4143 mm
2.	4009,5 - 4005 mm
3.	978,7 - 981,2 mm
4.	22 - 20 mm
5.	252 - 250 mm
6.	239 - 236,5 mm
7.	3023,3 - 3022,3 mm
8.	3030,7 - 3028,7 mm
9.	155 - 153 mm
10.	871,2 - 869,2 mm
11.	2794 mm - Wheelbase
12.	488 - 482 mm
13.	488 - 482 mm
14.	82 - 79,5 mm
15.	750,9 mm
16.	750,9 mm
17.	440,5 - 435,5 mm
18.	440,5 - 435,5 mm
19.	299,5 - 295,5 mm
20.	500 - 495 mm
21.	500 - 495 mm
22.	594,2 - 593,4 mm
23.	594,2 - 593,4 mm
24.	283 - 282,2 mm
25.	283 - 282,2 mm
26.	1970 - 1968 mm
27.	642,9 - 639,5 mm
28.	750,9 mm
29.	290,5 mm
30.	295,5 mm
31.	299,5 - 295,5 mm
32.	103 - 100 mm
33.	1177,5 - 1175,5 mm
34.	1692,5 - 1689,5 mm
35.	2610 - 2606 mm
36.	2040,5 - 2037,5 mm
37.	1912,5 - 1909,5 mm
38.	1359 - 1357 mm
39.	1573 - 1571 mm
40.	270 - 268 mm
41.	665,5 - 663,5 mm
42.	440 - 438 mm
43.	32,25 - 31,25 mm

Section V-V is through the engine mountings. Dimensional information can be found in the 90 engine mounting dimensions.

130 Chassis



M772126

Chassis alignment dimensions

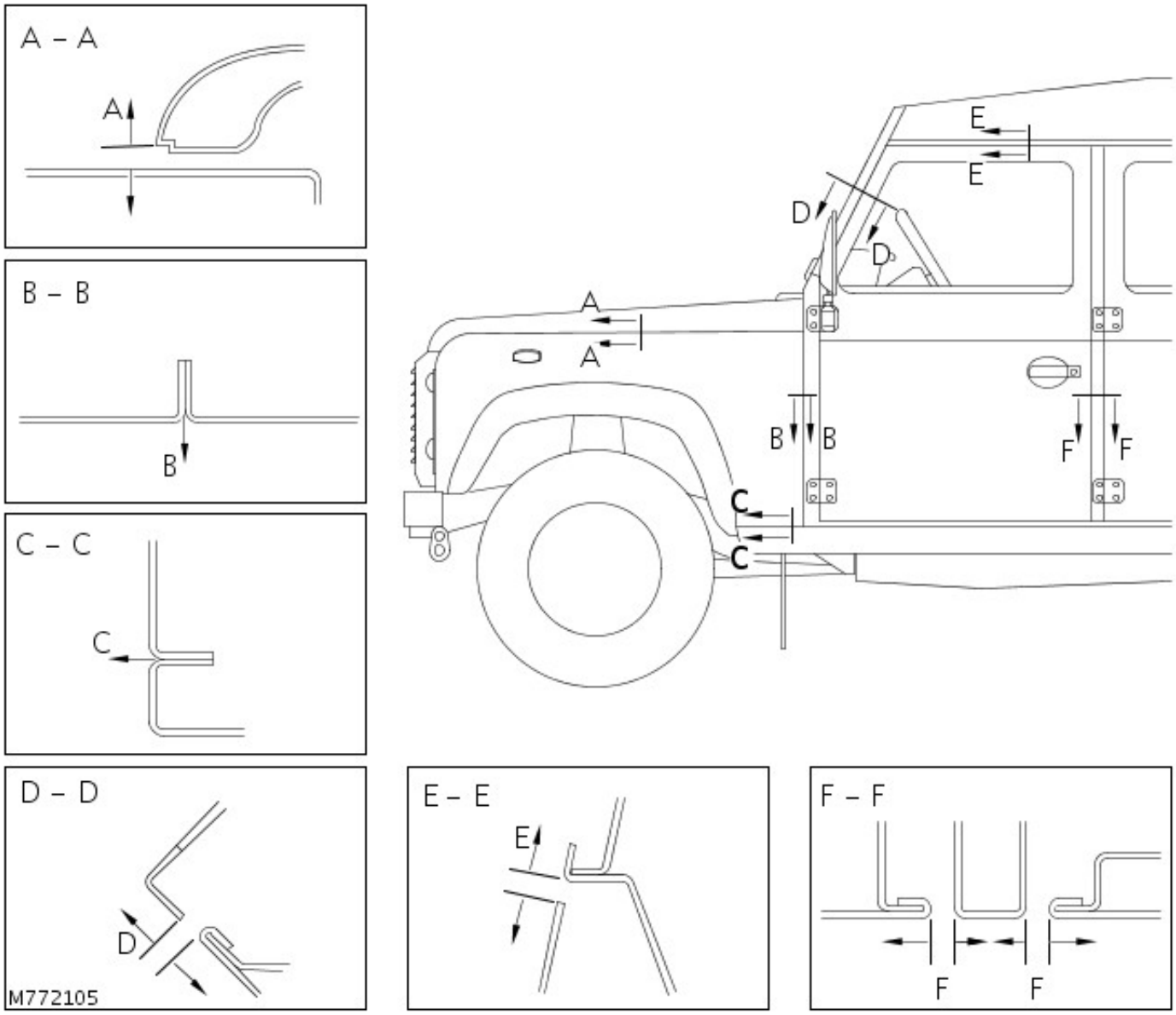
• NOTE: The above dimensions are for the Land Rover 130 chassis frame. For additional measurements, refer to the Land Rover 110 chassis frame drawing and alignment dimensions.

No./Letter	Dimension
A	Front datum

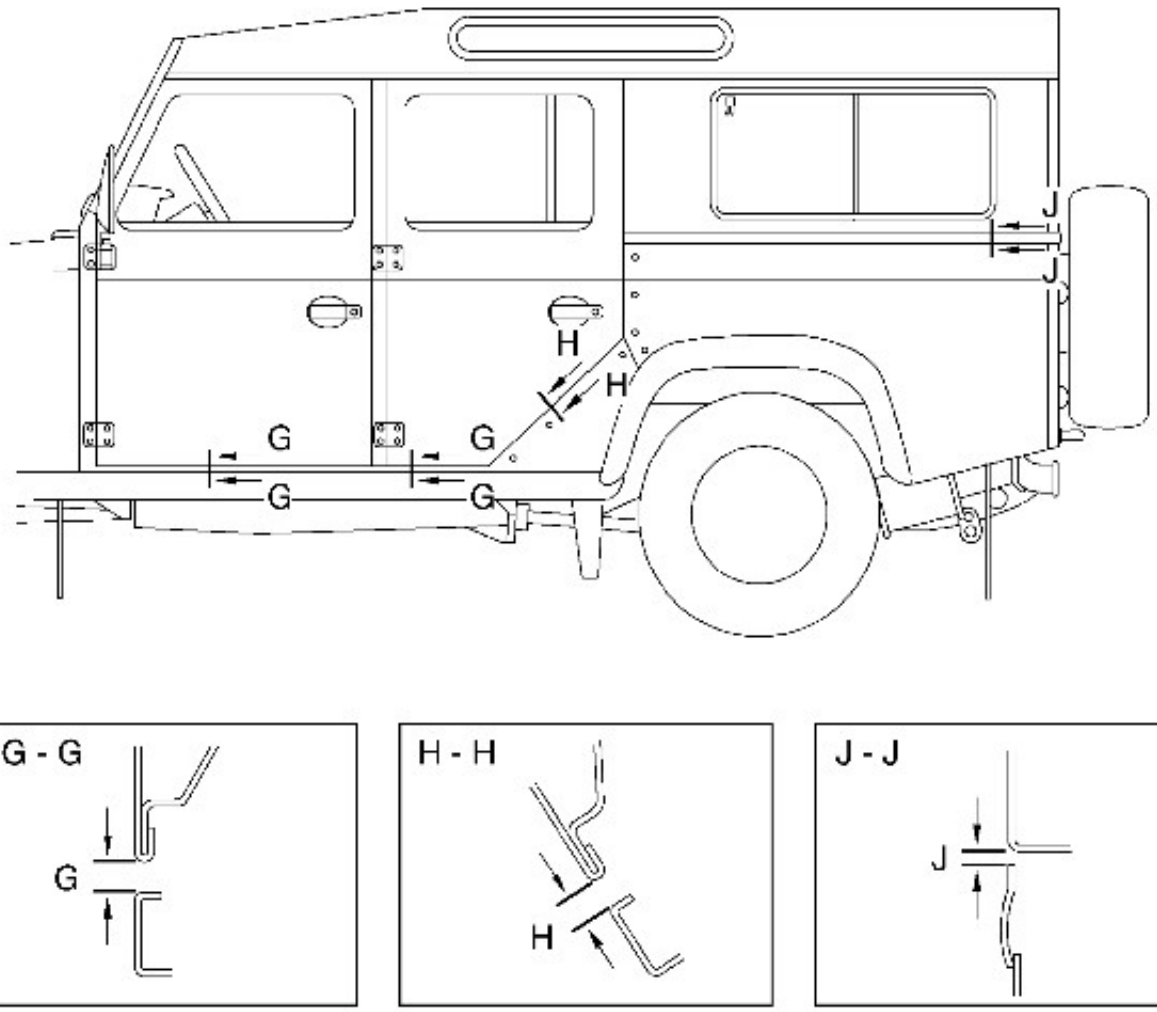
B	Chassis Datum
C	Front axle centre line
D	Rear axle centre line
E.	Chassis Datum, section A-A
1.	663,0 mm reference only
2.	3569,3 - 3567,3 mm
3.	2421,8 - 2419,8 mm
4.	2317,5 - 2314,5 mm
5.	2188,3 - 2185,3 mm
6.	2119,5 - 2117,3 mm
7.	1990 - 1988 mm
8.	1970 - 1968 mm
9.	2401,8 - 2399,8 mm
10.	110,0 mm reference
11.	149,7 - 146,7 mm reference dimension
12.	3225,8 mm wheelbase

GAP AND PROFILE INFORMATION

The following information is to be used as a guide to assist the technician in refitting exterior body panels and trim items, to achieve a correctly aligned and cosmetically acceptable vehicle.

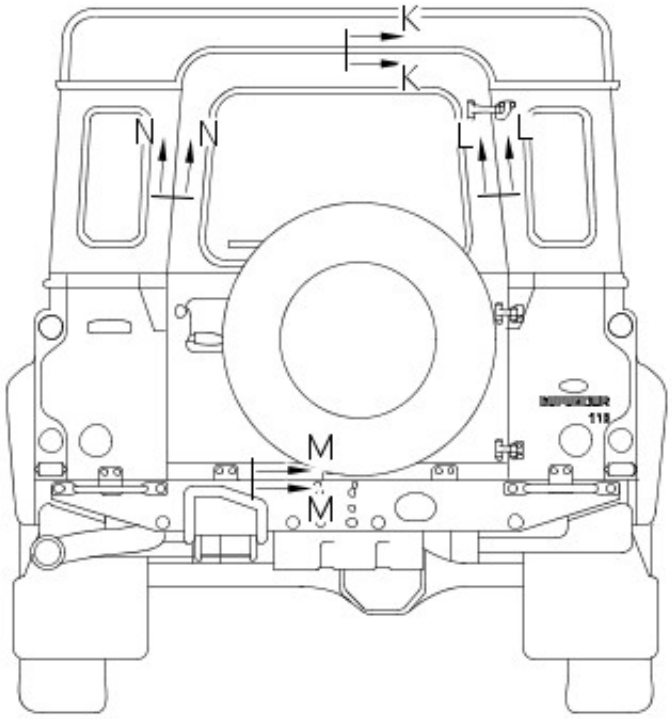


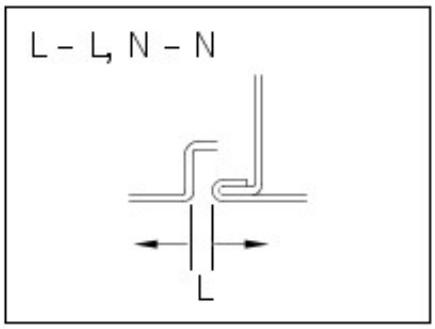
- Section A-A, Bonnet to wing gap A = 3 - 8 mm. To be parallel within 2 mm
- Section B-B, Wing to 'A' post lower, gap B = 0. Profile = ± 1 mm
- Section C-C, Wing to sill, gap C = 0. Profile = ± 1 mm
- Section D-D, Screen aperture to door frame , gap D = 5 - 9 mm
- Section E-E, Door frame to roof, gap E = 7 - 11 mm
- Section F-F, Front and rear door to 'B'/'C' post gap F = 7 - 11 mm

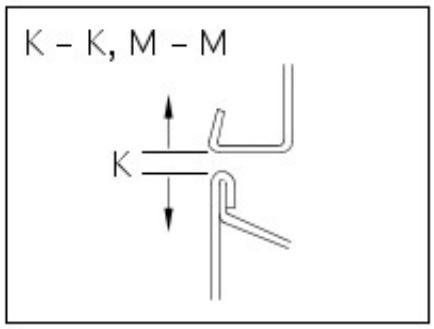


M772106A

- Section G-G, Door to sill gap G = 7 - 11 mm. Door profile to sill = 0 to = + 2 mm
- Section H-H, Rear door to body gap H = 7 - 11 mm. Door profile to body = 0 to = + 3 mm
- Section J-J, Body side lower to body, gap J = 0 - 4 mm. To be parallel within 2 mm







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- Section K-K, Roof to taildoor, gap K = 7 - 9 mm. Profile = ± 1 mm
- Section L-L, N-N, Body side to taildoor, gap L = 56 - 7 mm. Profile = ± 1 mm
- Section M-M, Body rear to taildoor, gap M - 7 - 9 mm

Front End Sheet Metal Repairs - Bulkhead Assembly

Removal and Installation

Removal

All vehicles

1. Disconnect both battery leads, negative lead first.
2. Remove front fender side panel.
   For additional information, refer to: Front Fender Side Panel (501-27 Front End Sheet Metal Repairs, Removal and Installation).
3. Remove RH and LH front upper wing. For additional information, refer to: Front Fender Top Panel LH (501-27 Front End Sheet Metal Repairs, Removal and Installation).and For additional information, refer to: Front Fender Top Panel RH (501-27 Front End Sheet Metal Repairs, Removal and Installation).
4. Remove headlamp mounting panels.
5. Remove windshield frame.
   For additional information, refer to: Windshield Frame (501-27 Front End Sheet Metal Repairs, Removal and Installation).
6. Remove both front doors.

Vehicles built up to 12/2006

7. Remove lower fascia panel. For additional information, refer to: (501-12 Instrument Panel and Console)

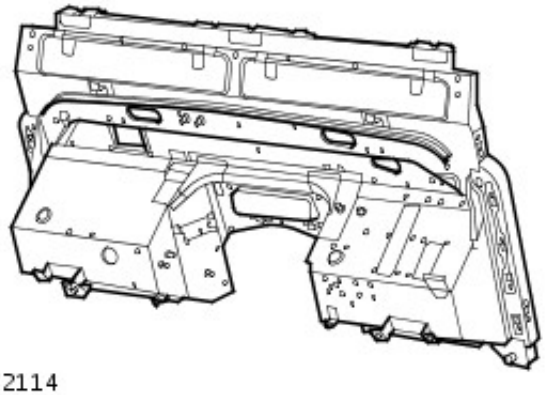
   Instrument Panel Lower Section - Vehicles Built From: 07/2001 (Removal and Installation),
   Instrument Panel Lower Section - Vehicles Built From: 07/1998 (Removal and Installation),
   Instrument Panel Lower Section - Vehicles Built Up To: 07/1998 RHD (Removal and Installation),
   Instrument Panel Lower Section - Vehicles Built Up To: 07/1998 LHD (Removal and Installation).

All vehicles

8. Models with A/C: Remove relevant A/C pipes.
9. Remove front grille.
10. Drain cooling system.
    1. 4.0 -
       For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03A Engine Cooling - 4.0L, General Procedures).
    2. Tdi -
       For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03B Engine Cooling - 2.5L (Tdi) Diesel, General Procedures).
    3. Td5 -
       For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03C Engine Cooling - 2.5L (Td5) Diesel, General Procedures).
    4. 2.4L Diesel -
       For additional information, refer to: Cooling System Draining, Filling and Bleeding (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, General Procedures).
11. Remove radiator and charge air cooler.
12. Models with A/C: Remove condenser.
13. Remove air cleaner assembly.
14. Remove heater unit.For additional information, refer to: (412-02 Heating and Ventilation)

Heater Core - Vehicles Without: Air Conditioning (Removal and Installation),
Heater Core and Evaporator Core Housing - LHD (Removal and Installation),
Heater Core and Evaporator Core Housing - RHD (Removal and Installation),
Heater Core and Evaporator Core Housing (Removal and Installation).

15. Remove brake booster assembly.
16. Remove heater ducts.
17. Remove both front seats.
18. Remove front carpets.
19. Release all relevant harnesses and position aside.
20. Remove facia support bracket.



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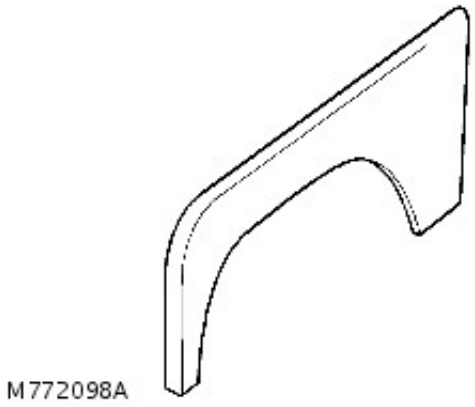
Installation

1. Prepare and clean panel joint faces. Ensure all necessary grommets and sealant is applied to new bulkhead.
2. Reverse removal procedure.
3. Bleed brake system.
   For additional information, refer to: Brake System Bleeding (206-00 Brake System - General Information, General Procedures).
4. Adjust headlamps.
   For additional information, refer to: Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).
5. Water test after refitting.

Front End Sheet Metal Repairs - Front Fender Side Panel

Removal and Installation



Removal

1. Disconnect both battery leads, negative lead first.
2. Remove wheelhouse eyebrow.
3. Remove wheelhouse liner.
4. RH side: Remove aerial.
5. Remove air intake hose.
6. Remove bolts securing front fender side panel.

Installation

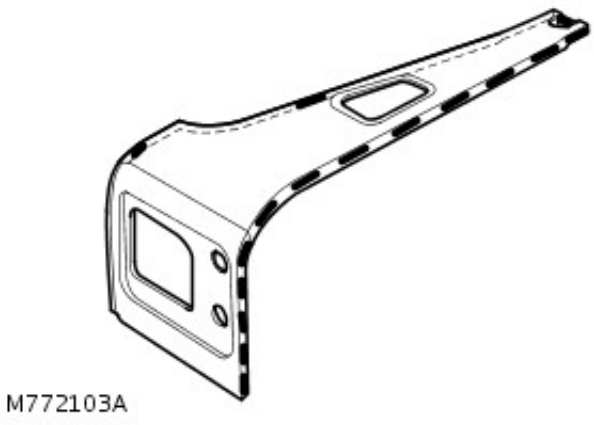
1. Prepare and clean panel joint faces.
2. Reverse removal procedure.

Front End Sheet Metal Repairs - Front Fender Top Panel LH
Removal and Installation

Removal

1. Disconnect both battery leads, negative lead first.
2. Remove headlamp assembly.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
3. Remove headlamp mounting panel.
4. Remove radiator.
   1. Tdi -
      For additional information, refer to: Radiator (303-03B, Removal and Installation).
   2. Td5 -
      For additional information, refer to: Radiator (303-03C, Removal and Installation).
   3. 4.0 -
      For additional information, refer to: Radiator (303-03A, Removal and Installation).
   4. 2.4L Diesel -
      For additional information, refer to: Radiator (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
5. Recover refrigerant from A/C system.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
6. Remove receiver drier.
   1. Tdi -
      For additional information, refer to: Receiver Drier (412-03B, Removal and Installation).
   2. Td5 -
      For additional information, refer to: Receiver Drier (412-03C, Removal and Installation).
   3. 4.0 -
      For additional information, refer to: Receiver Drier (412-03A, Removal and Installation).
   4. 2.4L Diesel -
      For additional information, refer to: Receiver Drier (412-03 Air Conditioning - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
7. Remove relevant A/C pipes.
8. Remove relevant heater intake pipes.
9. Remove screen washer reservoir.
10. Remove wheelhouse liner.
11. Remove bolts and release welds securing panel, remove

panel.



Installation

1. Prepare and clean panel joint faces.
2. Reverse removal procedure.
3. Adjust headlamps.
   For additional information, refer to: Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).

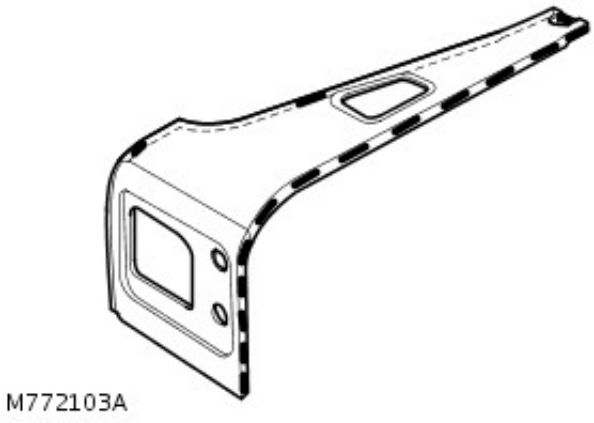
Front End Sheet Metal Repairs - Front Fender Top Panel RH

Removal and Installation

Removal

1. Disconnect both battery leads, negative lead first.
2. Remove headlamp assembly.
   For additional information, refer to: Headlamp Assembly (417-01 Exterior Lighting, Removal and Installation).
3. Remove headlamp mounting panel.
4. Remove radiator.
   1. Tdi -
      For additional information, refer to: Radiator (303-03B, Removal and Installation).
   2. Td5 -
      For additional information, refer to: Radiator (303-03C, Removal and Installation).
   3. 4.0 -
      For additional information, refer to: Radiator (303-03A, Removal and Installation).
   4. 2.4L Diesel -
      For additional information, refer to: Radiator (303-03 Engine Cooling - 2.4L Duratorq-TDCi HPCR (103kW/140PS) - Puma, Removal and Installation).
5. Recover refrigerant from A/C system.
   For additional information, refer to: Air Conditioning (A/C) System Recovery, Evacuation and Charging (412-00 Climate Control System - General Information, General Procedures).
6. Remove relevant A/C pipes.
7. Position PAS reservoir aside.
8. Remove wheelhouse liner.
9. Remove aerial.
10. Remove vacuum solenoid valve.
11. Release clips securing coolant reservoir.
12. NOTE: LH fender shown.

    Remove bolts and release welds securing panel, remove panel.



Installation

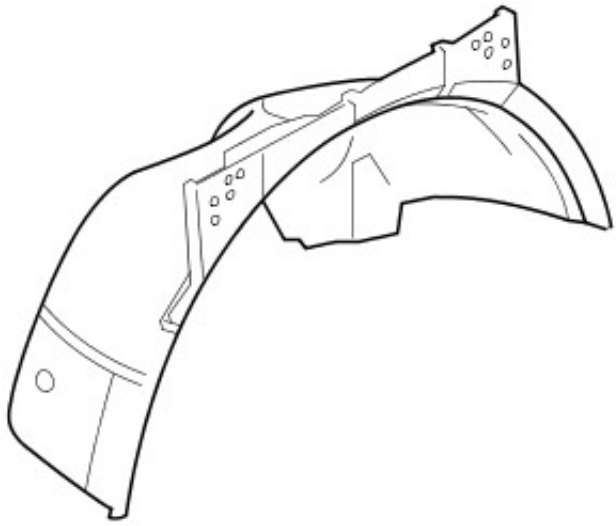
1. Prepare and clean panel joint faces.
2. Reverse removal procedure.
3. Adjust headlamps.
   For additional information, refer to: Headlamp Adjustment (417-01 Exterior Lighting, General Procedures).

Front End Sheet Metal Repairs - Front Wheelhouse

Removal and Installation

Removal

1. Remove the front wheel speed sensor and shield, if fitted. For additional information, refer to: Front Wheel Speed Sensor (206-09 Anti-Lock Control - Traction Control, Removal and Installation).
2. Remove the front fender top panel. For additional information, refer to: Front Fender Top Panel LH (501-27 Front End Sheet Metal Repairs, Removal and Installation).or For additional information, refer to: Front Fender Top Panel RH (501-27 Front End Sheet Metal Repairs, Removal and Installation).
3. Collect the wheelhouse.



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Installation

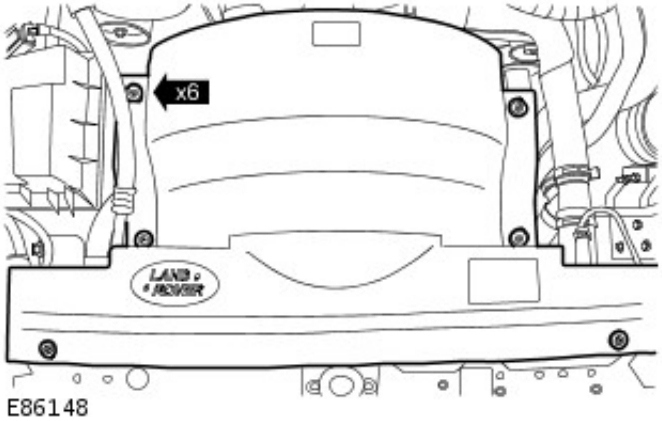
1. Fit the wheelhouse.
2. Fit the front fender top panel. For additional information, refer to: Front Fender Top Panel LH (501-27 Front End Sheet Metal Repairs, Removal and Installation).or
   For additional information, refer to: Front Fender Top Panel RH (501-27 Front End Sheet Metal Repairs, Removal and Installation).
3. Fit the front wheel speed sensor and shield, if fitted. For additional information, refer to: Front Wheel Speed Sensor (206-09 Anti-Lock Control - Traction Control, Removal and Installation).

Front End Sheet Metal Repairs - Hood Latch Panel

Removal and Installation

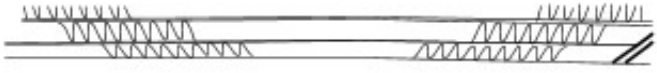
Removal

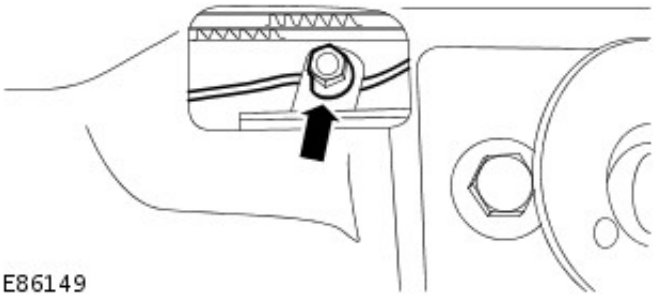
1. Disconnect the battery ground cable.
   For additional information, refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables, General Procedures).
2. Remove the radiator grille.
   For additional information, refer to: Radiator Grille (501-08 Exterior Trim and Ornamentation, Removal and Installation).
3. Remove the cooling fan upper shroud.
   - Release the 6 clips.



E86148

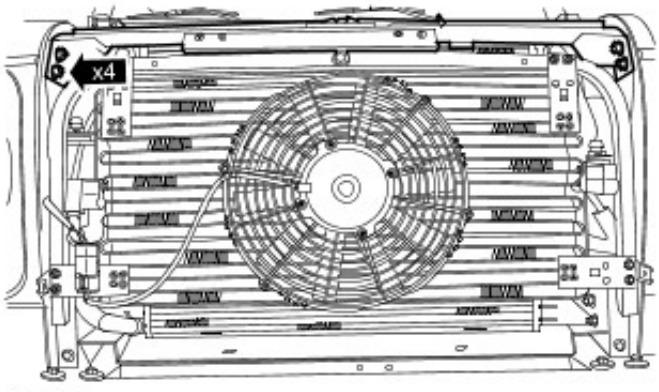
4. Loosen the hood release cable.





E86149

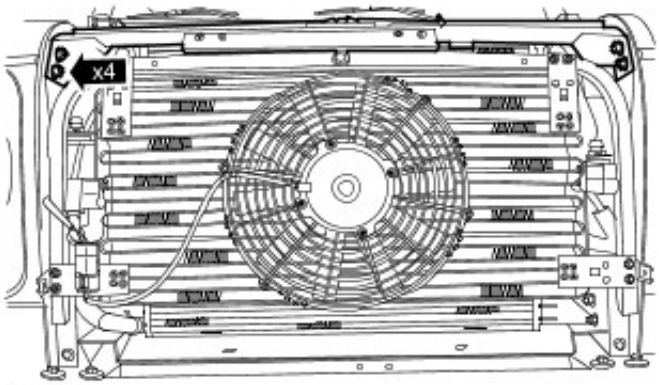
5. Remove the hood latch panel.
   - Remove the 4 nuts and studs.



E86150

Installation

1. To install, reverse the removal procedure.



E86150

- Tighten the nuts to 23 Nm (17 lb.ft).

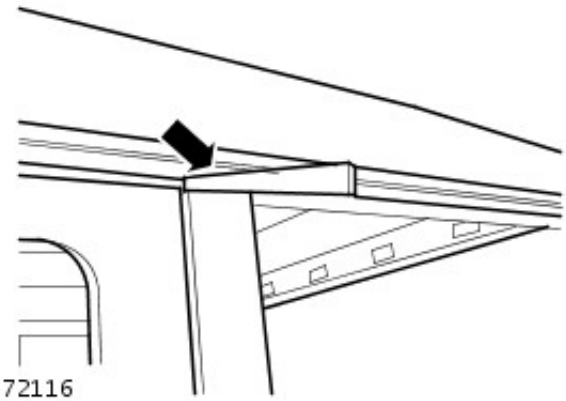
2. Connect the battery ground cable.
For additional information, refer to: Battery Connect (414-01 Battery, Mounting and Cables, General Procedures).

Front End Sheet Metal Repairs - Windshield Frame

Removal and Installation

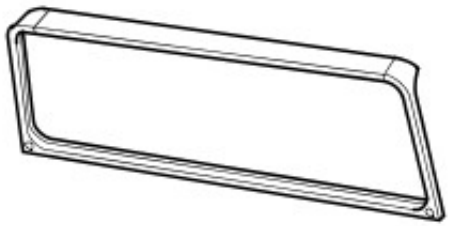
Removal

1. Disconnect both battery leads, negative lead first.
2. Raise side of vehicle.
3. Remove front and centre headlining sections.
4. Remove both A-pillart trims.
5. Remove front door aperture seals.
6. Release upper front corner of rear door aperture seal.
7. Remove both wiper pivot arms.
   For additional information, refer to: Front Wiper Pivot Arm (501-16 Wipers and Washers, Removal and Installation).
8. Remove windshield.
9. Remove all roof fixings, back to the B-pillar.
10. Release sealant securing front edge of roof.
11. Insert wedges into top of both B-pillars. This will allow access for removal of screen aperture.



M772116

12. With assistance remove windshield frame.



M772119

Installation

1. Prepare and clean panel joint faces.
2. NOTE: When refitting, ensure windshield frame is correctly fitted onto location pins in bulkhead.

   Reverse removal procedure. Fit new foam seal to top edge of windshield frame.

3. NOTE: White roof vehicles use a white sealant. Coloured roof vehicles use a black sealant.

   When applying sealant to top edge of windshield frame, the correct colour sealant must be used, see note below.

Roof Sheet Metal Repairs - Roof Panel

Removal and Installation

Removal

1. Disconnect both battery leads, negative lead first.
2. Remove rear bench seats.
3. Remove front, centre and rear sections of headlining.
4. Remove all bolts securing roof.
5. Carefully cut sealant securing front edge of roof to windshield aperture.

Installation

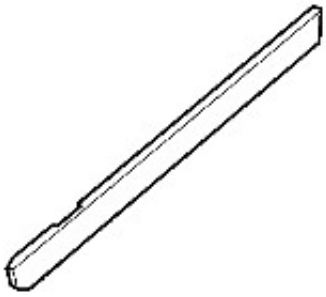
1. Prepare and clean panel joint faces.

M772115

2. Reverse removal procedure.

Side Panel Sheet Metal Repairs - Front Rocker Panel

Removal and Installation



M772111

Removal

1. Remove bolts securing front rocker panel to body, discard seal.

Installation

1. Prepare and clean panel joint faces. Refit new seal.
2. Reverse removal procedure.

Side Panel Sheet Metal Repairs - Rear Rocker Panel

Removal and Installation

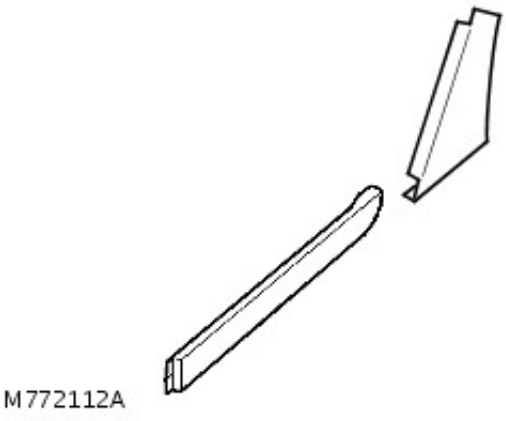
Removal

- NOTE: When replacing the rear rocker panel, the dogleg lower panel must also be replaced.

1. Disconnect both battery leads, negative lead first.
2. Remove door aperture seal.
3. Remove rear wheelhouse eyebrow.
4. Remove rivets and bolts securing rocker panel and dogleg panel to the body.

Installation

1. Prepare and clean panel joint faces.



2. Reverse removal procedure.

Side Panel Sheet Metal Repairs - B and C-Pillar Assembly

Removal and Installation

Removal

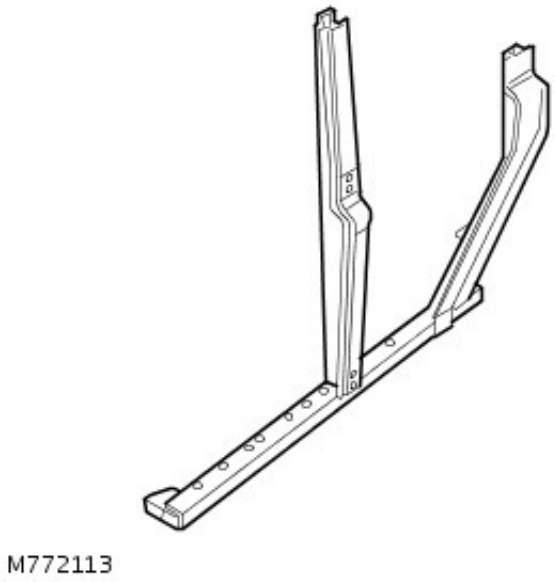
1. Disconnect both battery leads, negative lead first.
2. Remove rear door and striker.
3. Remove front safety belt retractor.
   For additional information, refer to: Front Safety Belt Retractor (501-20, Removal and Installation) / Front Safety Belt Retractor (501-20 Safety Belt System, Removal and Installation).
4. Remove front and rear carpets.
5. Remove front seat.
6. Remove rear seat.
7. Remove front, centre and rear sections of headlining.
8. NOTE: Assembly is held on with bolts.

   Remove front and rear rocker panels. For additional information, refer to: (501-29 Side Panel Sheet Metal Repairs)

   Front Rocker Panel (Removal and Installation),
   Rear Rocker Panel (Removal and Installation).

Installation

1. Prepare and clean panel joint faces.



M772113

2. Reverse removal procedure.

Rear End Sheet Metal Repairs - Rear Lamp Mounting Panel

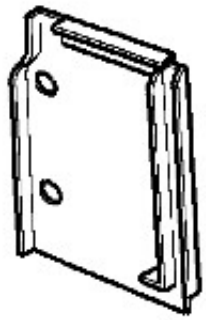
Removal and Installation

Removal

1. Disconnect both battery leads, negative lead first.
2. Disconnect generator.
3. Remove rear bench seat.
4. **RH side:** Remove tail door.
   For additional information, refer to: Taildoor (501-03 Body Closures, Removal and Installation).
5. Remove rear lights and reflector.
6. **LH side:** Remove licence plate and taildoor striker.

Installation

1. Prepare and clean panel joint faces.



M772118

2. Reverse removal procedure.

Rear End Sheet Metal Repairs - Rear Quarter Upper Panel

Removal and Installation

Removal

1. Disconnect both battery leads, negative lead first.

2. Remove front, centre and rear sections of headlining.

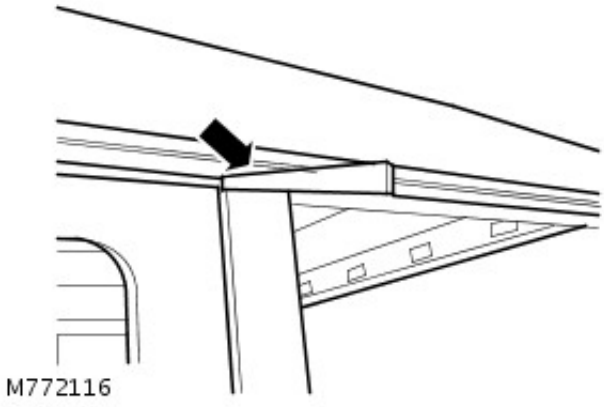
3. Release upper edge of front door aperture seal.

4. Release upper edge of rear door aperture seal.

5. Remove fixings from front edge of roof, and along side being replaced.

6. Release sealant securing front edge of roof.

7. Insert wedges into top of both B-pillar and C-pillar. This will allow access for removal of body side.



M772116

8. RH side: Remove tail door.

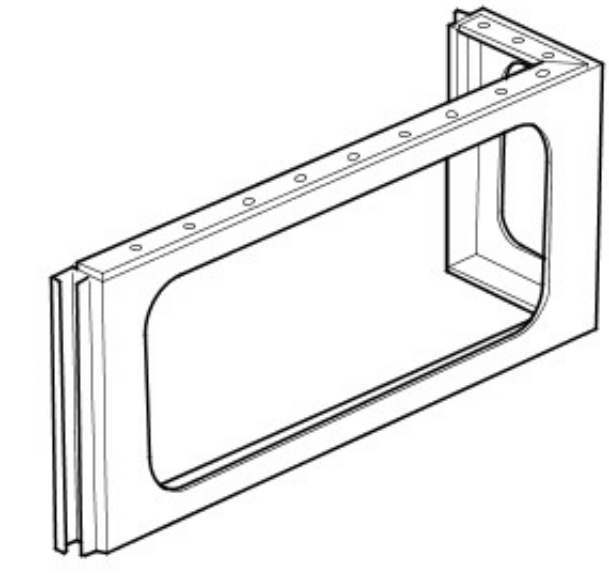
9. Remove side window.

10. Remove rear sixth light.

11. Remove all bolts securing rear quarter upper panel.

Installation

1. Prepare and clean panel joint faces.



M772117

2. NOTE: When refitting, ensure rear quarter upper panel is correctly fitted onto location pins.

Reverse removal procedure.

Rear End Sheet Metal Repairs - Rear Quarter Lower Panel

Removal and Installation

Removal

- NOTE: In this procedure the bodyside capping and the corner capping are also changed.

M772101A

1. Disconnect both battery leads, negative lead first.
2. Remove rear quarter upper panel.
   For additional information, refer to: Rear Quarter Upper Panel (501-30 Rear End Sheet Metal Repairs, Removal and Installation).
3. Remove all rear lamps and reflectors.
4. LH side: Remove licence plate and lamp.
5. LH side: Remove taildoor striker.
6. RH side: Remove fuel filler and grommet.
7. Remove all bolts and rivets securing rear quarter lower panel.

Installation

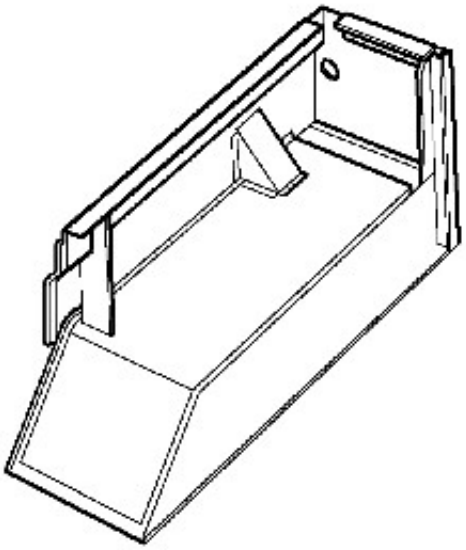
1. Prepare and clean panel joint faces.

M772102A

2. NOTE: When refitting, ensure rear quarter lower panel is

correctly fitted onto location pins.

Reverse removal procedure.



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