FREELANDER TECHNICAL BROCHURE

TECHNICAL ACADEMY

PART OF ROVER GROUP

Preface

This Technical Brochure has been issued to support the introduction of the Land Rover Freelander model range. The information contained within the brochure relates to the features and specification of the model range at launch.

Every effort has been made to ensure the information contained in this document is correct. However, technical changes may have occurred following it's publication and you should be aware that these will not, as a matter of course, be subject to any subsequent updating.

All applicable technical specifications, adjustments procedures and repair information can be found in the latest version of the relevant Workshop Manual or Electrical Trouble Shooting Manual. Alternatively, the information can be displayed on TestBook.

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Land Rover Model Line-Up

The Land Rover Model line-up currently comprises Defender, Discovery and Range Rover vehicles.

Initially the Defender, or the original Land Rover as it was called, was seen as a short-term stopgap, responding to post war vehicle supply shortage. World-wide demand mushroomed, however, and 50 years later the Defender is acclaimed as the worlds finest 4WD utility workhorse and has a uniquely recognised silhouette. Defender is a world-wide icon truly underpinning the Land Rover brand and has unrivalled off-road capability.

Launched in 1989, the Discovery was positioned deliberately as the champion of the Land Rover brand in the leisure sector. Since its launch it has won many awards for both its design and off-road ability. In response to customer research the Discovery underwent a major face-lift in 1994 (95 Model Year), which included a revised interior and exterior, R380 gearbox and the introduction of the 300 Tdi engine. Further changes have been introduced and production volumes have increased considerably over the original 550 units per week.

New Range Rover was launched in September 1995; the new luxury flagship model not only surpassed the Classic Range Rover’s legendary off-road capability, but also improved the on-road ride and handling characteristics to provide a true alternative to the world’s finest luxury cars. The Range Rover successfully combines styling cues from the Classic Range Rover with state of the art technology developed by Land Rover engineers. Range Rover extends the frontiers of 4WD technology and serves to ensure that Land Rover’s leadership in the 4WD marketplace continues.

Land Rover Freelander

Progressive and continual developments over the recent past have resulted in an expansion of the whole 4WD market. This has particularly affected the "leisure" sector of the marketplace, which can now be subdivided into large, medium and small segments.

Land Rover already successfully competes in the large and medium segments with the Discovery model range. To take advantage of the further opportunities now available in the 4WD small and medium segments of the Leisure sector, it has now launched Freelander.

Freelander

Figure 1

Freelander is something new from Land Rover. It is built to be adaptable and accessible, broadening the appeal of the Land Rover Brand. It features many innovative solutions designed to create car-like ride and handling for enjoyable and adventurous driving, both on the road and off it.

Freelander is designed to be modern and contemporary, without denying it's Land Rover heritage. A range of body styles are available: the three door comes in either Softback or Hardback versions and there is also a five door Station Wagon.

The Freelander model line-up is as follows:

- **Freelander i** - *(3 or 5 door, equipped with a petrol engine)*
- **Freelander di** - *(3 or 5 door, equipped with a diesel engine)*
- **Freelander XEi** - *(3 or 5 door, equipped with a petrol engine & additional features)*
- **Freelander XEdi** - *(3 or 5 door, equipped with a diesel engine & additional features)*

For precise details of model specifications, refer to current literature.

Key Product Features

As previously mentioned, Freelander vehicles incorporate many innovative features. Some of these are new to Land Rover. All reinforce the values and qualities of the Land Rover Brand. The following summarises many of the key product features. (N.B. Emphasis has been given to those features which are considered to be of particular importance to technical staff working in dealer “after-sales”):

- *All round independent suspension*.
- *Power assisted rack and pinion steering*.
- *Permanent four wheel drive.*
- *Four channel ABS.*
- *Electronic Traction Control.*
- *Hill Descent Control.*
- *Integrated Body/Chassis design.*
- *Use of engineering polymers and other advanced materials.*
- *Driver and passenger airbags.*
- *Pyrotechnic front seat belt pretensioners.*
- *Three-point centre rear seat belt (where three rear seat belts fitted).*
- *Sophisticated integrated vehicle security system.*
- *1.8 litre K Series petrol engine.*
- *2.0 litre L Series diesel engine.*
- *5-speed gearbox.*
- *Intermediate reduction drive.*
- *Wide range of accessories.*

Many of the features described above are explained in more detail later in this document.

Overview of Component Locations

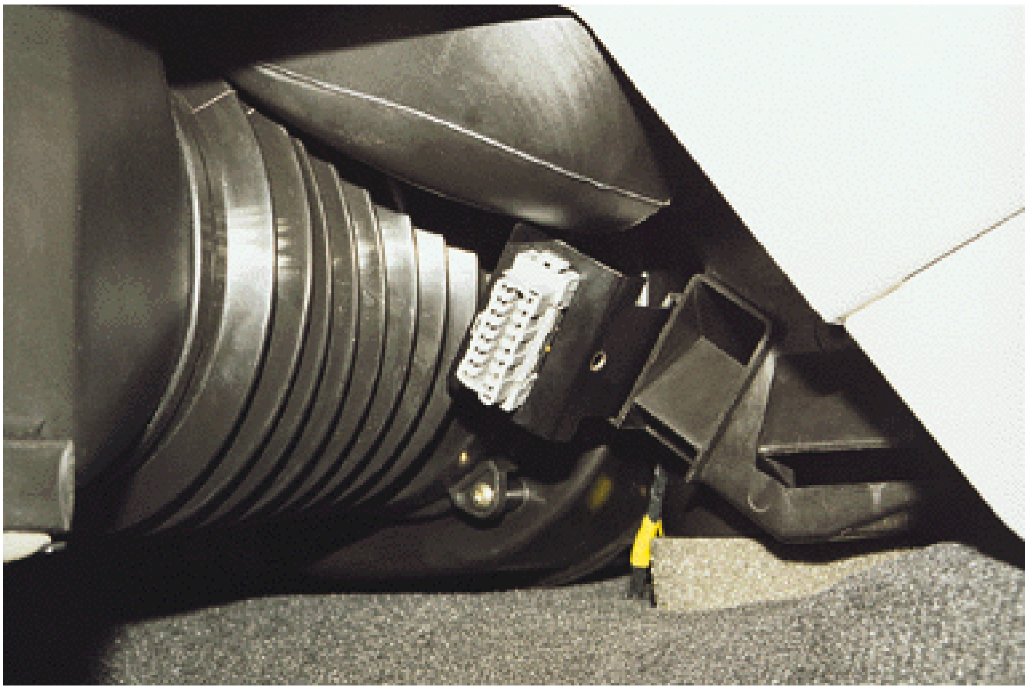
The following table details the installed locations of a selected number of critical vehicle components. The information refers specifically to right hand drive vehicles.

Under Bonnet Components	Installed Location
Battery	L/H Engine Compartment
ECM (MEMS)	L/H Engine Compartment To Rear Of Battery
ECM (EDC)	L/H Engine Compartment To Rear Of Battery
Main Relay (Diesel)	To Rear Of EDC ECM
Fuel Line Primer Bellows (Diesel)	Incorporated Into Fuel Line Rear Of Engine Compartment
Engine Management Relay Module (Petrol) Inc: Main Relay HO2S Relay Fuel Pump Relay Starter Relay	Secured To Moulding To Rear Of ECM
Relay Module Inc: Condenser Fan Relay Cooling Fan Relay 1 Cooling Fan Relay 2 A/C Compressor - Clutch Relay	Secured To Moulding To Rear Of ECM
Under Bonnet Fusebox	L/H Engine Compartment
Glow Plug Fuse (70 A)	Secured To Engine Compartment Fusebox
Clutch Master Cylinder	Secured To Engine Compartment Bulkhead
Clutch Slave Cylinder	Housed Within A Fabricated Bracket On Gearbox
Brake Master Cylinder	Secured To Brake Servo
Brake Servo	Secured To Engine Compartment Bulkhead
ABS Modulator	R/H Front of Engine Compartment
PCRV	R/H Engine Compartment To Rear Of ABS Modulator
Vehicle Jack	L/H Rear Engine Compartment
Road Speed Transducer (Active On Non-ABS Only)	Housed Within Gearbox
Bonnet Release Lever	R/H Footwell
Passenger Compartment Fusebox	Behind Cover Below Steering Wheel
Central Control Unit	Engaged To The Rear Of The Passenger Compartment Fusebox.
SRS DCU	Underneath Heater Centre Console
Rear Stowage Box	Load Space Floor
Diagnostic Socket	Behind L/H Side Of Centre Console

TestBook

Diagnostic testing of the various systems on Freelander is performed using TestBook.

Communication with each system is carried out via 16 pin diagnostic connector situated above the transmission tunnel. On RHD vehicles the connector is situated to the left of the centre console, and on LHD vehicles to the right of the centre console. See illustration below.



TestBook connector

Figure 2

In all circumstances the blue diagnostic lead DTC0061A should be used.

CCU Introduction

Since the introduction of the very first motor vehicle, late in the nineteenth century, manufacturers have continually searched for ways to improve the product and enhance the level of standard equipment fitted. This is particularly true of mass produced vehicles. Manufacturers have gradually achieved improved levels of standard equipment, system performance and reliability through careful revision and redesign.

Many of the changes and improvements made to motor vehicles, particularly those introduced during the last ten years, have been the direct result of the considerable technological advancements in vehicle electronics. As a result, it has become possible to design and fit vehicles with systems and features, which are both user friendly and incorporate complex functionality. These systems serve to satisfy the customer's spiralling demands for more and more features.

Most modern features, such as the vehicle security and anti-lock braking systems, are powered electrically. Rather than rely on mechanical control, these systems are often electronically controlled and therefore require the incorporation of an ECU (Electronic Control Unit).

ECU's are populated with solid state components. The effective capacity of any given ECU will depend upon, and be matched to, the complexity of the vehicle system the ECU is to control. The complexity of many modern vehicle systems is considerable, (especially in comparison to those used in the past). ECU's receive input signals, regarding the state of the system, from various sensors and switches and distribute outputs signals to actuators. ECU's are designed to match their application and configured to react in certain predetermined ways in response to the specific input signals received.

Advances in technology have enabled an increase in the effective capacity of ECU's. This has resulted in the manufacture and use of ECU's which are capable of controlling systems with much greater complexity. In some applications, it has resulted in the use of a "single" ECU to control several systems.

The Freelander model range uses such an ECU. In this case, the unit is referred to as the CCU (Central Control Unit). This unit controls the following vehicle systems:

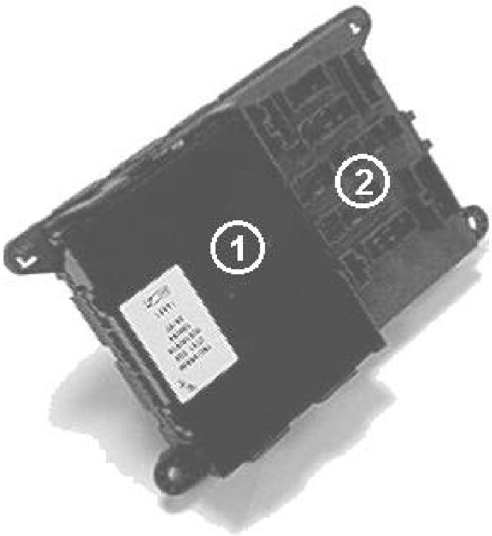
- Vehicle Security System
- Interior and Rear Fog Lamps
- Tail Door Operation
- Audible and Visual Warnings

In addition, the CCU also incorporates the following features:

- Power-up Strategy
- Timer Control
- Programmable Features
- Memory Buffer

CCU (Central Control Unit)

The CCU is attached to the in-car fuse box. The CCU is detachable from the fuse box and can be replaced separately if required. The illustration below shows the installed location of the CCU. The location is identical on right and left hand drive vehicles i.e. it is always attached to the rear of the fusebox, which is always located beneath the steering column.



CCU

1. Fusebox 2. CCU

Figure 3

TestBook can be used to communicate via a serial link with the CCU. TestBook must be used to configure the CCU, where feature programming (to suit market specification and vehicle application), is permitted or required. The VIN (Vehicle Identification Number) is entered during this process. Once the VIN has been entered it cannot be removed from the unit or altered using TestBook.

In order to establish communication with the CCU, TestBook must be connected to the Diagnostic port via its serial lead. The Diagnostic port is located in the passenger’s footwell (changes with drive hand). Once connected the appropriate “application” should be selected via the relevant on-screen menu.

CCU Features

The following text provides an outline of the features controlled by the Freelander's CCU. The outline includes descriptions of the various vehicle systems and incorporates information, such as component locations. Please remember to refer to the relevant section of the Repair Manual, TestBook and Electrical Reference Library for information regarding repair sequences, wiring diagrams and specifications.

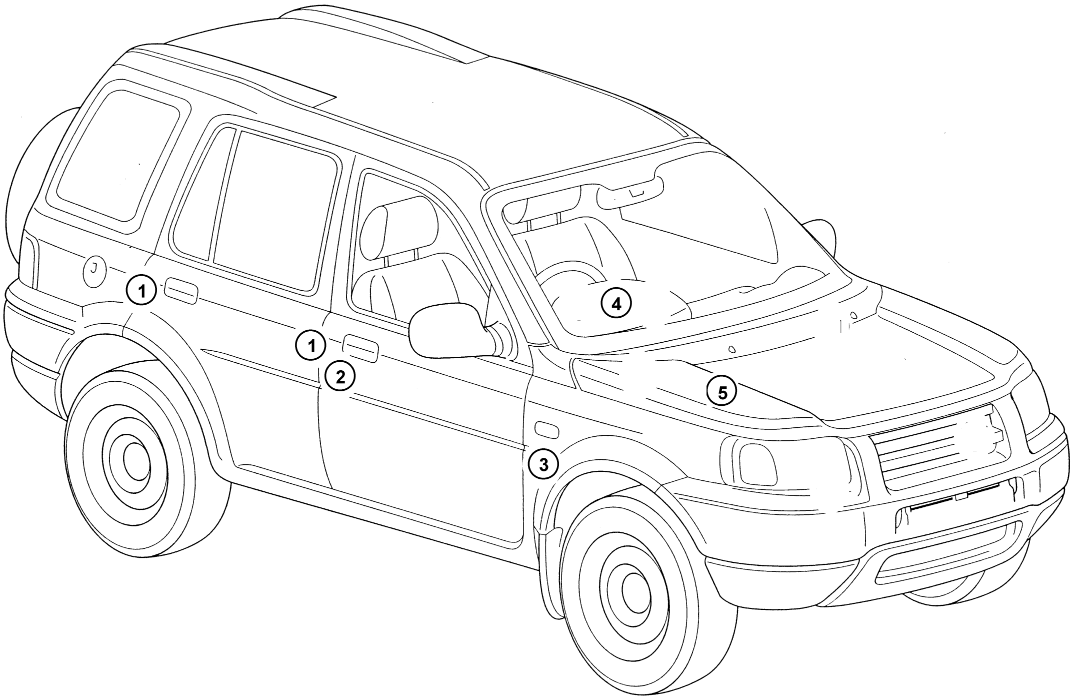
Transit Mode

Freelander derivatives feature many programmable CCU configurations. One of these is referred to as transit mode. Transit mode is designed to save on battery charge whilst the vehicle is in transit, i.e. post manufacture and prior to sale. Vehicles will be set in transit mode prior to being despatched from Land Rover.

Transit mode saves on battery charge by reducing the number of electrical features available for use whenever it is set. Therefore, features such as remote handset receiver power, interior lamps, CDL, tail door actuator and tail door window, will not operate until transit mode is removed. An audible warning will be sounded by the CCU buzzer as described in the Warning Sounds section, if the vehicle is in transit mode with the ignition on and the engine not running. Transit Mode must be removed using TestBook at PDI.

Vehicle Locking

The following illustration, of a silhouette of a Freelander Station Wagon, shows the installed location of the various components associated with the vehicle locking system.



1. Latches.
2. Key Barrel.
3. CCU.
4. RF Reciever.
5. CDL Switch.

Figure 4

Locking Terminology

In this document reference is made to various vehicle locked states. For clarity the following terms will be used: CDL locked, locked and super locked. The term “CDL locked” will be used to refer to the condition attained following operation of the CDL switch. The term “locked” will be used to refer to the state attained following a successful key lock operation. The term “super locked” will be used to refer to the state attained following a successful key super lock operation, or a remote lock operation.

CDL (Central Door Locking) Switch

1. Central Door Locking Switch.

Figure 5

On all models a CDL switch is mounted in the centre console (see figure 3). This switch allows the occupants to centrally lock the vehicle without arming the alarm, (similar to conventional sill lock). The vehicle can also be centrally unlocked from the switch, providing the alarm is disarmed.

The vehicle will not centrally lock from the CDL switch if the inertia switch is in the tripped state. In addition, the CCU will automatically unlock all doors from the CDL locked state, in cases where it detects the inertia switch moving to the tripped state whilst the alarm is disarmed.

Key & Remote Handset Locking

In addition to the CDL switch, the vehicle can be locked and unlocked using the door key or the remote handset. The precise way in which a vehicle responds to a key or remote handset input, with regard to vehicle locking/unlocking and alarm arming/disarming, will depend upon the programmed state of the CCU.

The programmed state of the CCU will be configured automatically when the vehicle's Market Option is set. The Market Option selected is determined by territory. New vehicles are programmed during the manufacturing process. In service TestBook must be used to set the Market Option. Once the Market Option has been set the CCU will function according to a pre-determined strategy. Some features within these strategies will be fixed, whilst a number will remain selectable, e.g. the precise locking and unlocking functionality.

In summary, vehicles can be:

- CDL Locked = *vehicle locked via CDL switch*
- Key Locked = *turn the top of the key towards the rear of the vehicle once*
- Key Super Locked = *turn the top of the key towards the rear of the vehicle twice (note: the second turn must be made within 1 second of the first)*
- Remote Locked (provides super lock) = *single press of the lock button on the remote handset*.

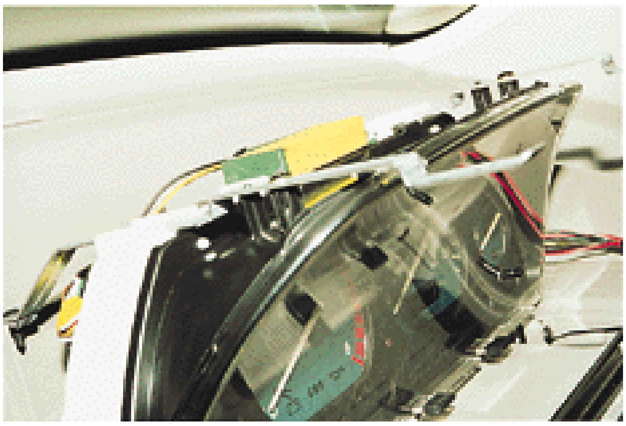
SPE (Single Point Entry)

An additional feature, referred to as SPE (Single Point Entry), is selectable on all models. This feature is designed to enhance the security of the vehicle and it's user. SPE will operate when unlocking the vehicle from the superlocked state using the remote handset.

The remote handsets transmit a coded frequency signal. This signal is received by a unit located on top of the instrument pack (as Shown in the following illustration). This unit transmits the lock/unlock information directly to the ECU, which wil respond accordingly.

In such circumstances, a single press of the unlock button will cause the driver's door to fully unlock and the passenger's doors to change from the superlocked state to the locked state. Access to the vehicle's interior will be permitted through the unlocked driver's door, but not through any of the passenger's doors.

In addition, the vehicle will effectively enter a single point entry condition in a number of alternative circumstances. For example, whenever the EKA (Emergency Key Access) code is successfully entered and the vehicle was originally super locked, it will move the passenger door locked status from super locked to locked. Also, if the EKA state is entered and the ignition is switched on and a valid remote handset is within range of the switch, then the passenger door locked status will move from super locked to locked.



Single Point Entry (SPE)

Figure 6

Additional Locking Information

It should be noted that any CDL or arm request made using the key or the remote handset will be ignored while the ignition is on (although the driver's door will mechanically lock in response to a key lock attempt). In addition, if any of the passenger compartment doors are open when a superlock request is received, then the system will only attempt to lock.

In line with the fuctionality of other Land Rover products, whenever the inertia switch is tripped, while the ignition is on and the alarm is disarmed, all the doors will be unlocked (irrespective of their current locked state). Subsequent attempts to lock the doors will be then be inhibited until the ignition is switched off and the driver's door is opened and closed and the inertia switch is reset.

Tail door release, carried out by way of the exterior door handle, can be achieved while the vehicle is in the unlocked and disarmed state. The CCU will inhibit operation of the tail door release mechanism if the vehicle is traveling at a speed greater than approximately 5 km/h. The CCU receives a vehicle speed input signal from, either the road speed transducer on vehicles not equipped with ABS, or from the ABS ECU on vehicles equipped with the WABCO braking system.

It is not possible to slam lock the driver's door on any Land Rover Freelander derivative. The driver's door latch is designed to mechanically inhibit slam locking. If it is necessary to externally lock a vehicle without arming the alarm, then the driver's door must be sill locked and then the vehicle must be slam locked using a passenger door. Alternatively, the vehicle could be CDL locked and then key locked by the driver's door, in circumstances where there are two keys available and the ignition is switched on.

In order for the system to respond to a remote handset lock or unlock request, the handset must be synchronised with the CCU. It will become un-sychronised with the CCU in circumstances where the power supply to either the remote handset or to the vehicle is lost.

To re-synchronise a remote handset with the CCU, press the lock or unlock button five times, or any combination of both buttons five times, in succession with the ignition off. Alternativly, insert the key into the ignition (with the remote attached), turn the ignition on and the transponder system (see Friendly Remobilisation) will re-synchronise the remote handset with the CCU automatically. If this method is used, ensure that only one remote handset is within range of the ignition switch when the ignition is switched on. This measure will prevent signals being transmitted simultaneously from two or more remote handsets.

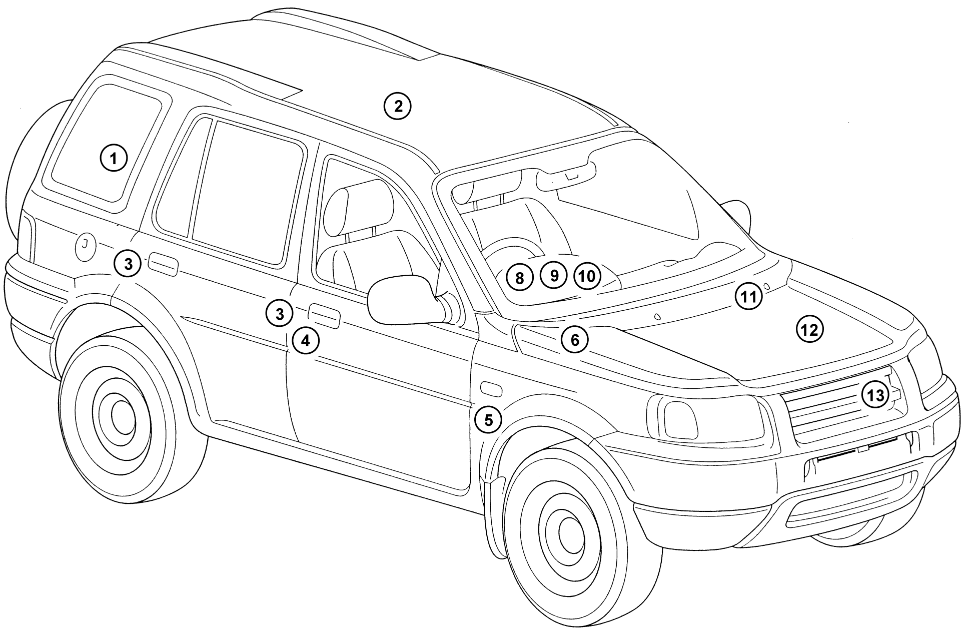
Latch Motor Protection

The side door latches used on Freelander models are innovative units which have been jointly developed by Land Rover and BMW. The units are unique in their design and are shielded for protection. To further enhance vehicle security and reduce complexity all switches, actuators and electrical systems are integrated into the latch assembly.

To prevent damage occurring to the door latch motors through continual operation, the system incorporates a Latch Motor Protection feature. This means the CCU will only allow a maximum of eight changes of state, i.e. a change from locked to unlocked, or from super locked to locked, to occur within 16 seconds.

The CCU will suspend operation of the latch motors if more than eight changes of state are requested within this period. The latch motor operation will always be suspended in the unlocked state and therefore in some circumstances, nine changes of state will be permitted. Once suspended, the latch motor operation will be suspended for a total of 16 seconds.

Alarm System Components



1. Tail Door Latch.
2. Volumetric Sensor.
3. Latches.
4. Key Barrel.
5. CCU.
6. Bonnet Switch.
8. RF Receiver.
9. Alarm LED.
10. Door Open Lamp.
11. Inertia Switch.
12. ECM.
13. Horn.

Figure 7

Alarm Operation

As described earlier, the CCU controls the vehicle's security system. Before continuing with a full description of the security system and of the features it possess on Freelander models, it should be understood that its precise functionality will be determined by the programmed state of the CCU, i.e. selected Market Option and state of dealer programmable features.

The table on the following page describes the configurations of each Market Option and also identifies the features which are programmable using TestBook.

The information included in the column headed "Name," provides the title of the alarm feature. The information included in the column headed "Function," gives more precise information regarding the operation of the feature. The information included in the "Market Option" column identifies the configuration of each Market Option specification, (see key below). The information in the last column, headed "Dealer Option," identifies those features which are selectable via TestBook.

Market Option	**Number**
Original Equipment (OE)	1
Transit Mode	2
UK & Europe	3
Australia & ROW	4
Japan	5
Holland & Belgium	6
Gulf	7

OE is a default configuration (CCU's supplied to Land Rover as OE). Transit Mode is a selectable "delivery" mode, (see description of Transit Mode earlier in this document).

Market Option & Alarm Configuration

Name	Function	Market Option	Dealer Option
Alarm	Full alarm system including LED enabled	1,3,4,6.	No
	Alarm function disabled	2,5,7.	No
Hazard Confirm	Hazards will flash with locking & unlocking	1,3,4,6.	No
	Function disabled	2,5,7.	No
Hazard Alarm	Hazards will flash with alarm sounding	3,5,7.	Yes
	Function disabled	1,2,5,7.	Yes
Alarm Sound	Sounder is continuously on	6.	No
	Sounder is pulsed	1,2,3,4,5,7.	No
Sounder Type	CCU will drive BBUS	6.	Yes
	CCU will drive Horn	1,2,3,4,5,7.	Yes
Locking Type	Super Locking enabled	1,3,4,6.	No
	CDL Locking only	2,5,7.	No
Super Locking	Remote handset single press = super lock	3,4,6.	No
	Remote handset double press = super lock	1,2,5,7.	No
SPE	Single Point Entry with Remote handset unlock	1,3,4,6.	Yes
	Function disabled	2,5,7.	Yes
Mislock	Sounder is pulsed during partial arm or EKA	1,3,4,6.	Yes
	Function disabled	2,5,7.	Yes
Continuous MEMS	Continuous transmission of MEMS signal	1,2,3,4,5,6,7.	No
	MEMS signal transmission is timed from crank		No
EKA	EKA entry suspended for 30mins after three failures	1,3,4,6.	No
	Function disabled	2,5,7.	No
Vol. Power	CCU will supply power to volumetric sensor	3,4,6.	No
	Function disabled	1,2,5,7.	No
Passive Immob’	System will passively immobilise and drive transponder	1,3,4,6.	No
	Function disabled	2,5,7.	No
Lamps On Unlock	Interior lights illuminate on with unlock	1,3,4,5,6,7.	No
	Function disabled	2.	No
Drop Glass One Shot	Tail door drop glass drives open fully automatically	3,4,5,6,7.	Yes
	Function disabled	1,2.	Yes

Alarm Arming & Disarming

The following table describes the effect on the security system of the various arming and disarming actions that can be carried out using the key, or the remote handset. It should be noted that although the vehicle can be locked and unlocked from the CDL switch in the centre console, the alarm cannot be armed or disarmed from this switch.

The precise response to an arming action will vary according to the selected Market Option and the programmed state of the CCU. The information shown in the table below should therefore be used in conjunction with the vehicle locking and unlocking information detailed earlier in this document and the Market Option information on the preceding page. It should also be noted that the alarm will not arm in any circumstance on vehicles set to the Japanese or Gulf Market Options.

In summary, vehicles with the alarm system enabled will react to a lock request in the following manner:

Lock Request	Perimetric Protection	Crank Inhibition	Engine Immobilised	Volumetric Protection
CDL Switch	No	No	No	No
Key Lock 1	Yes	Yes	Yes	No
Key Lock 2	Yes	Yes	Yes	No
Remote Lock 1	Yes	Yes	Yes	Yes

The following describes in more detail the way in which Freelander derivatives, which have the alarm system enabled, react to the various lock requests made.

When the alarm is fully armed using a Key Lock 1, or Key Lock 2 method (two turns within 1 sec), then the following will occur:

1. The vehicle will be locked in either CDL, or superlock mode.
2. The hazard lights will flash three times.
3. The LED will fast-flash for 10 seconds before changing to a slow-flash.
4. Perimetric protection, crank inhibition and engine immobilisation will be set.

To fully disarm an alarm which has been armed using either of these key methods, the remote handset unlock button must be pressed once. In circumstances where the handset is not available or is not communicating with the CCU, then the alarm can be fully disarmed using the key. This will require the entry of the EKA code, (as described later).

When an alarm is fully armed using a remote handset lock request the following will occur:

1. *The vehicle will be locked in super lock mode.*
2. *The hazard lights will flash three times (dependent on Market Option).*
3. *The CCT LED will fast-flash for 10 seconds before changing to a slow-flash.*
4. *Perimetric protection, crank inhibition and engine immobilisation will be set.*
5. *Volumetric protection will be set.*

To fully disarm an alarm which has been armed using the remote handset lock button, the unlock button must be pressed once. In circumstances where the handset is not available or is not communicating with the CCU, then the alarm can be fully disarmed using the key. This will require the entry of the EKA code, (as described later).

The reaction of the vehicle to a disarm request received from the remote handset will vary according to the CCU's programmed state and the vehicle's locked state, as explained. When the alarm is fully disarmed the following will occur:

1. *All vehicles being disarmed from the locked state (i.e. not superlocked), will unlock all doors. Vehicles being disarmed from the superlocked state, which do not have the SPE (single point entry) feature set, will also unlock all the doors. Vehicles being disarmed from the superlocked state, which do have the SPE feature set, will unlock the driver's door only and change all the other locks to the locked state following a single press of the unlock button. Following a second press on the unlock button all passenger doors will unlock.*

2. *The hazard lights will flash once.*
3. *Perimetric protection will be disarmed.*
4. *The vehicle will be re-mobilised.*
5. *Engine crank will be enabled*.
6. *Volumetric protection will be disarmed.*

It should be noted that unlocking a passenger door from the SPE unlocked state, i.e. driver's door unlocked all other doors locked, can be achieved using the remote or the key, or by operating the interior release lever twice. In addition, to unlock and open a locked passenger door from inside the vehicle the interior release lever must be operated twice, i.e. two pulls.

EKA (Emergency Key Access)

As has already been stated, vehicles set to Japan or Gulf Market Option do not arm the alarm under any circumstance. It is therefore possible to unlock these vehicles from their locked state by inserting the key into the driver's door and turning the top of the key once towards the front of the vehicle, (irrespective of the method used to lock the vehicle).

On vehicles set to all other Market Options (except Transit Mode), the alarm system will be armed (to some extent) whenever the vehicle is locked using the key or the remote handset (see preceding table). These vehicles can be subsequently unlocked and disarmed using the remote handset, as described above (see Arming & Disarming).

It should be noted that, although it is always possible to unlock a vehicle using the key, it is not possible to disarm a vehicle, which has the alarm system enabled, by turning the key once in the driver's door. However, it is possible to disarm a vehicle by way of the EKA feature.

The EKA feature enables a locked and armed vehicle to be unlocked and fully disarmed (and therefore re-mobilised), using the key. This procedure is particularly useful in circumstances where the remote handset is not available, or cannot be used.

The EKA feature involves the entry of a numeric code (containing four individual numbers) into the CCU. Each EKA code is randomly generated during the manufacturing process and bears no relationship with the vehicle's VIN. Each number contained within the code can be within the range of 1 to 15. The EKA code is entered by changing the state of the driver's door key switch. The state of the switch is changed by turning the key to the unlock and lock positions.

To further enhance vehicle security, all Freelander derivatives initiate a five and a half minute delay period prior to entering the EKA state. During this time the CCU will not accept any EKA digit input. There is no visual or audible warning given at any time to indicate the delay period has been started, is counting down or has been completed.

The delay period will be started whenever a vehicle is unlocked from the locked and armed state using the key, or in circumstances where it becomes necessary to re-mobilise a vehicle which has become passively armed, where a working remote handset is unavailable. Following the delay period the CCU will accept entry of the EKA code.

When the vehicle enters the delay period and EKA state, the following occurs:

1. *The driver's door will unlock*.
2. *The LED will continue to slow flash.*
3. *Perimetric protection will be suspended on all panels accept the bonnet*.
4. *Engine immobilisation will remain activated.*
5. *Engine crank disable will remain activated.*
6. *Volumetric protection will be deactivated if it was set.*

As described previously, once the delay period has been completed the CCU will accept entry of the EKA code.

It is possible to cancel the delay period, at any time during the five and a half minutes, using the handset or the key. Firstly, this can be achieved by pressing the unlock button on a working remote handset. This will unlock disarm and re-mobilise the vehicle as normal. Secondly, the lock button, on a working remote handset, or the key can be used to lock the vehicle, both actions will return the vehicle to a locked and armed state.

The CCU will ignore any further unlock signals received from the key switch during the five and a half minute delay period.

The delay period will not be initiated following an incorrect EKA code entry attempt when the driver's door is opened and then closed to prepare the vehicle for another attempt.

To enter the EKA code carryout the following process after completion of the delay period.

It should be noted that when entering the EKA code, both locking and unlocking alarm functions will operate as normal on the first turn of the key in either direction. However, subsequent turns in the same direction will not lock or unlock the vehicle. (For training purposes the EKA code used in this example is 3,6,2,11).

Remember that the process starts with the vehicle in the locked state and that the first turn to the unlock position will initiate the delay period.

1. *After five and a half minutes, turn the key to the unlock position **3 times**, i.e. the number of times that corresponds with the first digit of the code.*
2. *Turn the key to the lock position **6 times**.*
3. *Turn the key to the unlock position **2 times**.*
4. *Turn the key to the lock position **11 times**.*
5. *Turn the key to the unlock position once.*

If the EKA code (in this case 3,6,2,11), has been entered correctly the vehicle will unlock all doors, fully disarm and will be mobilised. Repeated entry of the EKA will be required following subsequent immobilisation, due to passive or key or remote arming.

If an attempt to enter the EKA code fails, then the vehicle will remain in the EKA state following the last turn to the unlock position. In this condition, the vehicle will continue to be immobilised and stay partially locked and protected. The vehicle will automatically enter a thirty minute time-out period, during which it will not respond to any further attempts to enter the EKA code, if three failed attempts are carried out consecutively.

If a mistake is made when entering the EKA code, then the system can be reset by either opening and closing the driver’s door, or by turning the ignition on and then off. An aborted attempt will be counted on the tally of failed attempts. If at any time you need to exit the EKA state then either open and then close the driver’s door before re-locking the vehicle, or transmit a valid remote handset lock or unlock signal.

Perimetric Protection

Perimetric protection refers to the protection offered against an illegal intrusion through any of the vehicle’s hinged panels and by removal of roof. The term perimetric is derived from the word perimeter, meaning an object’s boundary.

Perimetric protection is achieved by monitoring the state of the hinged panels and the roof, once the alarm has been armed. The panel open switches on the driver's door, passenger doors, tail door, bonnet and roof are all monitored by the CCU. If a panel opens once the alarm has been armed, then the alarm is triggered. The door switches are incorporated into the door latch assemblies. The following illustration shows the location of the bonnet switch.

1. Location of bonnet switch

Figure 8

Perimetric protection is activated once a valid arm request is received. If any panel is “open” when perimetric protection is activated, other than the roof, then the system will be armed in the partially armed state (see Partial Arming).

Volumetric Protection

Volumetric protection refers to the protection provided to the vehicle's interior. The volumetric sensor monitors this area and will trigger the alarm if it detects any unauthorised movement, whilst the alarm is armed appropriately.

In certain circumstances, e.g. when the vehicle is parked with a window open, the vehicle may need to be secured without the volumetric protection armed. This requirement can be catered for by using the appropriate locking procedure, as previously described.

Volumetric protection is a desirable feature of any vehicle security system and provides a high level of protection against theft. However, it can be the cause of considerable customer annoyance, and has a generated a reputation for causing false alarm triggers.

In recognition of this, a number of precautions have been taken on Freelander derivatives to prevent accidental or nuisance triggering occurring. These precautions include a settling period following system arming, a minimum trigger signal duration and a volumetric "gain" setting, specifically suited to the vehicle body style. The following describes the triggering conditions in more detail:

- *Following a suitable arm request, the CCU will refuse to act upon any movement detect signal supplied by the volumetric sensor, until a period of 15 seconds has elapsed. This gives sufficient time following door closure etc.*
- *Once armed the CCU will only trigger the alarm if a valid movement detect signal, i.e. a signal of at least 50 milliseconds duration, is received from the volumetric sensor. This ensures that spurious one-off movements are suitably ignored.*
- *If the alarm has been triggered (by any means), the CCU is programmed to ignore any movement detect signal supplied by the volumetric sensor for the duration of the alarm sounding period, i.e. 30 seconds. At the end of this period, the CCU will initiate another 15 second settling period, unless the maximum number of 10 alarm triggers (1 trigger on vehicles set for Hong Kong) has been reached since the last alarm arming, before it resets volumetric protection.*
- *A volumetric gain setting, suited to the body style of the vehicle will be issued by the CCU to the volumetric sensor. This setting is designed to avoid under/over sensitivity. The vehicle body style is automatically deduced by the CCU from the VIN stored in its memory. If required the setting can be tuned using TestBook.*

Engine Immobilisation

Engine immobilisation refers to the protection offered by the system against illegal engine start. Engine immobilisation is controlled by the CCU and provided in two ways. Both methods of engine immobilisation are active whenever the alarm is armed. The alarm LED will slow flash whenever engine immobilisation is active, to indicate the state of the alarm.

The two methods used to prevent the engine from running are engine crank disable and engine management inhibition. To immobilise engine crank, the CCU disables the engine crank relay circuit and so prevents operation of the starter motor. To prevent the engine from running, the CCU inhibits the sending of the coded engine enable signal to the engine management ECM when the ignition is switched on. This action prevents unauthorised operation of vital engine management systems.

The coded engine enable signal is sent from the CCU to the engine management ECM, whenever the CCU detects that the ignition switch is turned to position II while the alarm is disarmed and the system is not immobilised. This signal instructs the ECM to activate the engine management functions and enable the engine to run. In circumstances where the signal is not sent, is not received, or the signal received is not recognised, by the ECM, the engine is prevented from running (i.e. is immobilised).

To ensure the system functions correctly, the ECM must learn to recognise the coded signal sent by the CCU. This must be done when either unit is new and whenever either unit is replaced in service. The process is carried out using TestBook.

As described above, the engine immobilisation feature will be active (in other words will prevent the engine starting and running), whenever the alarm is armed using the key or the remote. In addition to this, the engine will become immobilised automatically in certain conditions. This automatic method is referred to as passive immobilisation. It does not require the driver to carry out a deliberate arming action and serves to enhance the level of protection provided against vehicle theft.

Passive immobilisation will arm automatically 5 seconds after the CCU senses that the ignition has been switched off and driver’s door has been opened, or 5 seconds after the driver’s door is opened and then the ignition is switched off. It will also arm 5 minutes after the ignition has been switched off if the driver’s door is not opened, providing that is, the ignition is not switched back on during this time. Finally, it will arm in circumstances where the alarm is disarmed and the ignition is not switched on for longer than 5 minutes.

As well as passive immobilisation, Freelander derivatives are equipped with “friendly” re-mobilisation. This feature provides automatic re-mobilisation of the engine in conditions where certain requirements are met. In other words, it enables automatic re-mobilisation of the engine, allowing it to start and run when required. As stated, friendly re-mobilisation occurs automatically and requires no deliberate action by the vehicle user.

Friendly Re-mobilisation Operation

Friendly re-mobilisation will occur immediately after the ignition is switched on, whenever the vehicle is disarmed and immobilised, providing the remote handset is within approximately 70 mm of the front face of the ignition switch. Once friendly re-mobilisation has occurred, the engine will start and run if cranked. As with passive immobilisation, this feature does not require the vehicle user to carry out any deliberate re-mobilisation or disarming action.

The remote handset, the CCU, a wire coil assembly placed around the steering lock, known as the steering lock antenna and the associated harness are the components which provide the friendly re-mobilisation feature. The installed position of the steering lock antenna is shown in the illustration below.

1. Steering Lock Antenna

Figure 9

The friendly re-mobilisation feature operates as follows:

- *Immediately after the ignition is turned on (with the vehicle disarmed and immobilised), the CCU will transmit a "ringing" waveform to the steering lock antenna.*
- *In response to this waveform, the steering lock antenna generates a magnetic field within a radius approximately 70 mm of the ignition switch front face.*
- *Provided the remote handset is within the required distance from the front face of the ignition switch, the magnetic field will cause the handset to transmit a re-mobilisation signal directly to the receiver and then to the CCU and the engine will be permitted to start and run as required.*

If a valid re-mobilisation signal is not received from the remote handset by the CCU within 1 minute of the ignition being switched on, then the CCU will stop transmitting the ringing waveform, until the ignition is turned off and back on again.

A passively immobilised vehicle, can also be re-mobilised by pressing the unlock button on the remote handset, or by entering of the EKA, as previously described. In circumstances where either of these methods are used, the CCU will automatically re-arm passive immobilisation if it does not receive an ignition-on signal within 5 minutes.

Partial Arming

In circumstances where an attempt is made to arm the alarm when the vehicle is not fully secure, i.e. one or more of the hinged panels is open at the time when the CCU receives the arm request, the alarm will enter the partially armed state.

The partial arming feature is designed to maximise the level of protection provided to the vehicle in such circumstances. The system achieves this by evaluating which panel (or panels), is open at the time when the alarm is armed, and subsequently activating as much of the alarm as is possible. In addition to the circumstances described above, the partial arming feature also enables the system to maximise the level of protection it provides in the event of a failure of one (or more) of the panel open switches or their respective wiring.

Freelander derivatives are able to enter four slightly different partially armed states. The precise partially armed state entered is determined by which panel is open. The four different states are defined as follows:

1. *Alarm armed with the driver's door open*.
2. *Alarm armed with the passenger door or doors open*.
3. *Alarm armed with the tail door open.*
4. *Alarm armed with the bonnet open.*

***Alarm armed with the driver's door open*.** If the vehicle enters the partially armed state due to an open driver's door, then the CCU will suspend activation of super locking and volumetric protection and will continue to monitor the panel left open. All other functions of the alarm system will be fully armed.

***Alarm armed with the passenger door or doors open*.** If the vehicle enters the partially armed state due to an open passenger door, then the CCU will suspend activation of super locking and volumetric protection and will continue to monitor the panel left open. All other functions of the alarm will be fully armed.

Alarm armed with the tail door open. If the vehicle enters the partially armed state due to an open tail door, then the CCU will allow activation of super locking, will suspend activation of volumetric protection and will continue to monitor the panel left open. All other alarm functions will be fully armed.

Alarm armed with the bonnet open. If the vehicle enters the partially armed state due to an open bonnet, then the CCU will allow activation of super locking and volumetric protection, and will continue to monitor the panel left open. All other alarm functions will be fully armed.

When an attempt is made to arm the alarm with one or more panels open, i.e. when the vehicle enters the partially armed state, a number of visual and audible warnings are provided to inform the vehicle user of the armed state. The precise warnings provided will be dependent upon the Market Option selected and the programmed state of the CCU.

An audible mislock warning sound may be given on some vehicles. This warning will be generated either by the vehicle's horn, or by the BBUS (Battery Backed UP Sounder). If the warning is generated by the horn then it will be a single sound of approximately 20 milliseconds duration. In cases where the BBUS generates the warning then it will be a single sound of approximately 100 milliseconds.

Two forms of visual indication may be provided when the vehicle enters the partially armed state. Firstly, there may be no fast flash from the alarm LED, immediately following entry of the armed state. Secondly, there may be no flash at all from the hazard warning lights, immediately following entry of the armed state.

To further enhance vehicle security, the CCU is programmed in such a way, that it allows a vehicle which has been armed in the partially armed state, to automatically "upgrade" to the fully armed condition. The CCU will initiate this change of state if it senses that the panel, that originally caused the mislock, has been securely closed. With the exception to partial armed states caused by an open driver's door, the CCU does not require a further arm request to upgrade to the fully armed state.

In circumstances where the partial armed state was caused by an open driver's door the CCU will require a further arm request. If a driver's door is subsequently closed after causing a mislock, then perimetric protection will be automatically extended to the driver's door. However, because the locked state of the door is not automatically upgraded, i.e. it remains in the unlocked state, then volumetric protection will not be armed, even if it was originally requested.

Alarm Trigger

When the alarm is set in the fully armed state it will be triggered by the CCU if it receives any of the following input signals:

- *Bonnet opening*.
- *Tail door opening.*
- *Any side door opening.*
- *Ignition switched on.*
- *A valid movement detect signal from the volumetric sensor (when volumetric protection armed).*
- *Removal of the roof (if it was in place when the alarm was armed)*.

In response to a valid alarm trigger input, the CCU will activate audible and visual warnings for a maximum duration of approximately 30 seconds. The precise type of warning generated will vary according to the Market Option selected and the CCU's programmed state.

When set, the audible warning will be provided by the vehicle's horn, by the alarm BBUS, or by both. The warning will either be continuous, or will be pulsed at 0.5 second intervals, i.e. 0.5 seconds on, off for 0.5 seconds, on for 0.5 seconds repeated. The visual warning will be provided by the hazard lights and will be pulsed at the same frequency, if set.

The CCU will trigger the alarm up to 10 times in any armed period. It will not trigger the alarm more than 10 times during this period, even if it receives further valid alarm trigger input signals. (N.B. Vehicles set for Hong Kong will only trigger alarm once during any set period).

The CCU incorporates a memory buffer. This enables the CCU to record the cause of the four most recent alarm triggers. Using this feature, the CCU can be interrogated via TestBook to establish precisely which input, or inputs, caused the CCU to trigger the alarm on the last four occasions.

Power-up Strategy

In line with security systems fitted to other Land Rover vehicles, the security system fitted to Freelander derivatives contains a power-up strategy. This feature enables the CCU to control the locked and armed state of the vehicle, whenever the vehicle's battery is connected.

The CCU remembers the state of the alarm whenever the battery is disconnected. When it is subsequently re-connected, the CCU will return the vehicle to the desired condition according to the following programme:

State when disconnected	State when reconnected
Unlocked	Unlocked
Locked	Locked
Perimetric protection armed	Perimetric protection armed
Volumetric protection armed	Volumetric protection armed
Alarm sounding	Alarm sounding
Mobilised	Mobilised
Immobilised	Immobilised
In EKA state	Perimetric and volumetric
Transmitters synchronised	All require re-synchronisation

Lamps & Warnings

In addition to the security system, the CCU controls a number of other body electrical features and systems including audible and visual warnings. The audio/visual warnings are the means by which the CCU can signal the occurrence of particular event or condition to the vehicle user.

The precise types of warning signal given will be dependent on the Market Option selected and the programmed state of the CCU. The following table details the specific Market Option configurations concerning the audible/visual warnings, and identifies which feature is selectable using TestBook.

The information in the column headed “Name,” incorporates the title of the warning feature. The information in the column headed “Function,” gives more precise detail regarding the operation of the feature. The “Market Option” column identifies the configuration of each specification (see key below). The last column headed “Dealer Option,” identifies the feature which is selectable via TestBook.

Market Option	Number
Original Equipment (OE)	1
Transit Mode	2
UK & Europe	3
Holland & Belgium	4
Australia & ROW	5
Japan	6
Gulf	7

OE (Original Equipment) is a default configuration (CCU’s supplied to Land Rover as OE). Transit Mode is a selectable “delivery” mode (see description of Transit Mode earlier in this document).

Name	Function	Market Option	Dealer Option
Cat Heat W/L	Warning lamp enabled (will operate as described)	6.	No
	Function disabled	1,2,3,4,5.	No
Seat Belt W/L	Warning lamp enabled (will operate as described)	5,6.	No
	Function disabled	1,2,3,4,7.	No
Brake W/L	Warning lamp enabled (will operate as described)	5.	No
	Function disabled	1,2,3,4,6,7,8	No

Warning Lamps

The CCU controls the operation of four warning lamps. (All four lamps are located in the instrument pack). The warning lamps are the door-open warning lamp, the catalyst overheat warning lamp, seat belt warning lamp and the handbrake warning lamp. The precise strategy used to determine the actuation of these warning lamps will depend upon the vehicle's Market Specification and programmed state of the CCU, (see previous page).

The door open warning lamp will be illuminated if the ignition is in Position II and any door or the bonnet or the tail door is open.

The catalyst overheat warning lamp will illuminate for approximately 5 seconds after ignition is switched to Position II to act as a bulb check function. Provided the catalyst heat switch and associated wiring are within specification, the lamp should then extinguish.

The catalyst over heat switch is located in the catalyst. It monitors the operating temperature of the catalyst and will have continuity when the catalyst is operating within its normal temperature range. If the catalyst over heat switch has blown (i.e. has become open circuit, normal operation in the case of catalyst overheat) the CCU will illuminate the warning lamp. A blown catalyst switch needs to be replaced and the cause investigated at the earliest opportunity, to decide whether a new catalyst is required or not.

The seat belt warning lamp will also illuminate for approximately 5 seconds after ignition is switched to Position II. This serves as a bulb check and a reminder to the driver to fasten the seatbelts.

The handbrake warning lamp also operates a bulb check sequence and will illuminate for approximately 5 seconds after ignition is switched to Position II. This sequence is controlled by the CCU. The handbrake warning lamp is also illuminated directly from the handbrake switch, whenever the handbrake is applied and by the brake fluid level switch. Neither of these methods are controlled by the CCU.

Warning Sounds

The CCU controls the operation of six audible warnings (i.e. warnings additional to the vehicle alarm, as previously described). The audible warnings are generated by a buzzer located inside the CCU. They are the *lights on alarm*, the *overspeed warning*, *CCU in transit mode alarm*, *CCU not programmed alarm, tail door drop glass not calibrated alarm* and the *remote handset battery low warning*. The precise strategy used to determine the actuation of these warnings will depend upon the vehicle's Market Specification and programmed state of the CCU.

The *lights on alarm* will operate as follows: The CCU internal buzzer will emit a continuous tone whenever the side lights are on and the ignition is "below" position II and the drivers door is open.

The *overspeed warning* will operate as follows: The CCU internal buzzer will emit a short tone intermittently (i.e. approximately once every 375 milliseconds, e.g. "bip........bip........"), if the ignition is in position II and the vehicle is travelling at a speed greater than approximately 116 km/h. The overspeed warning will remain operating in this way until the vehicle has slowed to a speed of less than approximately 113 km/h.

The CCU can be removed from the *transit mode* condition using TestBook. For a more comprehensive description of this condition refer to Programmable Features. The CCU in transit mode warning will operate as follows: The CCU internal buzzer will emit a 250 millisecond tone intermittently (i.e. approximately once every 125 milliseconds, e.g. "beep.....beep....."), if the ignition is in position II or greater and the engine is not running (no detected oil pressure) and the CCU is in the pre-sale power saving transit mode. During normal circumstances the vehicle should not be passed to a customer in this state.

The *CCU not programmed alarm* operates as follows: The CCU internal buzzer will emit 750 millisecond tone intermittently (i.e. approximately once every 125 milliseconds, e.g. "beep.....beep....."), when the ignition is in position II (or greater) and will continue when the engine is running if the CCU has not been successfully programmed at Land Rover. In all normal circumstances a vehicle should not be passed to a customer in this state.

Interior Courtesy Lamps

5-door Freelander derivatives are fitted with 3 courtesy lamps, whereas 3-door vehicles are fitted with 2 coutesy lamps. The main courtesy lamps are fitted in the headlinning and the luggage compartment. The courtesy lamps may be illuminated in one or other of the following ways:

- *When any of the vehicle's doors are opened*.
- *Whenever a valid unlock signal is received by the CCU with the vehicle previously locked*.

The courtesy lamps will be extinguished in one or other of the following ways:

- *Approximately 15 seconds after all doors have been closed*.
- *When the ignition is turned to Position II, at any time during the 15 second delay period (following closure of all doors).*
- *When a lock signal is received by the CCU during the 15 second delay period (following closure of all doors).*
- *Approximately 10 minutes after a door has been opened (and left open).*

Rear fog lamps

Freelander derivatives are all fitted with two rear fog lamps. The lamps are operated by way of a non-latching fog lamp switch located in the instrument binnacle. The rear fog lamps may be illuminated using the following procedure:

- *Press the rear fog lamp switch while the ignition is switched to position II and either the headlamps, or the front fog lamps, are switched on.*

The rear fog lamps are extinguished in one or other of the following ways:

- *Switching off the ignition.*
- *Switching off the headlamps if the front fog lamps are off.*
- *Switching off the front fog lamps if the headlamps are off.*
- *Pushing the switch a second time.*

Once the rear fog lamps have been extinguished they will remain off until requested again by the driver pressing the rear fog lamp switch.

Description of Functionality - Tail Door

The tail door is one of the most complex systems fitted to the vehicle and is another system which the CCU controls. The tail door interacts with the rear wiper, tail glass and alarm. The CCU requires the following inputs and affects the following outputs respectively regarding the operation of the tail door:

Inputs
Ignition switch
Remote Transmitter
Roof off switch
Tail door open switch
Tail door handle open request switch
Drop glass switch on centre console
Drop glass up request switch (tail door handle key barrel)
Drop glass position sensor in tail window motor
Vehicle speed
Tail wiper park sense

Outputs
Courtesy lamps
Door open warning lamp
Tail door drop glass motor - up/down relays
Tail door latch actuator
Tail wiper
Internal sounder - drop glass calibration

To open the tail door, lift the handle located on the door’s exterior, (the tail door cannot be opened remotely). The tail door will only open if the vehicle is travelling at a speed less than approximately 5 km/h and the alarm is disarmed. If either or both of these requirements are not met, then the CCU will inhibit operation of the tail door actuator.

If these requirements are met, then the CCU will initiate the following sequence of actions to open the door. It will firstly lower the tail door glass by approximately 15 millimetres to a position referred to as the “clear of seal position.” It does this to ensure that the glass, which normally sits up into the aperture seal, is clear to allow the door to open. It then provides power to the tail door latch actuator for approximately 440 milliseconds. Finally, the CCU will park the rear wiper off-screen, if it was operating when the door handle was lifted.

The door is “slam closed” in the conventional way, remembering that the tail door glass will be approximately 15 millimetres from its fully closed position at this time. The CCU will identify door closure by detecting the change of state of the tail door switch. Approximately 0.4 seconds after the door has closed the CCU will provide power to the tail door glass regulator and will drive the window to the fully closed position. The CCU allows a 0.4 second delay period, to give time for the glass to stabilise following door closure.

Tail Door Drop Glass - Operation

The tail door drop glass is operated by way of the switch located on the centre console. The CCU controls the operation of the tail door drop glass in response to a request received from the switch. The CCU is programmed with information vital to the correct operation of the drop glass. To ensure the CCU controls the operation as desired, it must be aware of the precise glass position.

1. Tail door drop glass switch

Figure 10

A calibration procedure is therefore used to inform the CCU of the position of the drop glass. Once calibrated, the CCU will maintain an awareness of the glass position at all times. The calibration routine must be carried out in cases where the battery has been disconnected. The drop glass will also require re-calibration if the glass position has been moved or replaced.

The calibration procedure is as follows:

1. *Reconnect the battery (the tail door drop glass (if fitted) will automatically drive to bottom, i.e. fully open - only if the vehicle is unlocked and disarmed).*
2. *Turn the ignition switch to position II.*
3. *Hold the tail door drop glass switch in the up position until the glass has reached the top and stopped moving, (i.e. fully closed), or operate the drop glass by inserting the key into the tail door key barrel (roof on door closed).*

During the calibration procedure, the CCU will set it's 'glass at bottom' position, in its memory when the drop glass reaches the bottom, i.e. fully open position. It will then store the 'glass at top' position when the drop glass has been driven up to top, i.e. its fully closed position.

If the glass stalls whilst going up for any reason, e.g. due to an obstacle in the way, then the glass will automatically drive to bottom again. In such a case, calibration will not have been successfully carried out and a warning beep will be heard. Before calibration is possible the obstacle must be removed.

Calibration will only be possible when the vehicle is in the disarmed state and when the tail door is fully closed. If the vehicle's battery is disconnected and reconnected whilst the alarm is armed, then the tail door drop glass will automatically begin its calibration procedure by driving down to the fully open position the next time the vehicle alarm is disarmed. The CCU will not initiate any tail door drop glass movement until the alarm is disarmed.

In addition to the conventional open and close operation of the tail door drop glass, the CCU can be programmed to operate the drop glass in a lazy unlocking mode and one-touch open mode.

The lazy unlocking mode is provided as an additional convenience feature, to ease loading in circumstances where opening of the tail door is not required or desirable. Inch down mode enables the drop glass to be positioned as desired. Whereas, the one-touch open mode enables the drop glass to be fully opened in response to a momentary press of the switch.

To operate lazy unlocking, the ignition must be switched off, the tail door wiper must be parked off-screen and the remote handset unlock button must be pressed and held down for approximately 1 second. Lazy unlocking will cause the vehicle to unlock and disarm, as described earlier, and the drop glass to drive to the fully open position. The drop glass can then be closed by operation of the key switch located on the exterior door handle, as described below, or by way of the window switch located on the centre console.

The one-touch open mode can be initiated by pressing the tail door drop glass switch in the open direction for less than approximately 0.2 seconds. Once initiated the drop glass will drive to its fully open position in a single movement. Although it should be noted that the one-touch open mode will only initiate if the ignition is turned to position II and the tail door wiper is parked off-screen. If the wiper is operating when the one-touch function is activated then the wiper will park off-screen automatically before the window is driven.

If the drop glass is open, it can be driven to the closed position, from outside the vehicle using tail door key switch. This feature may be useful in cases where the lazy unlock feature has been used to open the drop glass, or where the drop glass has been left open for some other reason.

The tail door drop glass will drive upwards in the closed direction, in cases where the tail door is closed and the key is inserted into the door switch and turned to the clockwise position. The drop glass will continue driving upwards towards the closed position for as long as the key is held in the clockwise position.

It should be noted that this key operation will not lock the vehicle. If you release either the key or the console switch prior to closure of the drop glass, it will drive to the fully open position.

1. Key in the clockwise position

Figure 11

The drop glass will automatically drive to the fully closed position once it reaches the "clear of seal" position, during this operation. If the key is released from the clockwise position before the glass reaches this position, then CCU will automatically drive the glass down to the fully open position. The wiper will recommence operation automatically, in cases where the tail door drop glass is successfully closed and the wiper was operating before the drop glass was opened, if the ignition is on.

The CCU operates the tail door drop glass according to a slightly different strategy, in cases where the tail door is open at the time when the key is used to close the glass. In these circumstances, the CCU will suspend movement of the drop glass when it reaches the "clear of seal" position. It will then automatically drive to the fully closed position when the door is closed. If the key is released from the clockwise position before the drop glass reaches the "clear of seal" position, then the CCU will automatically drive it to the fully open position.

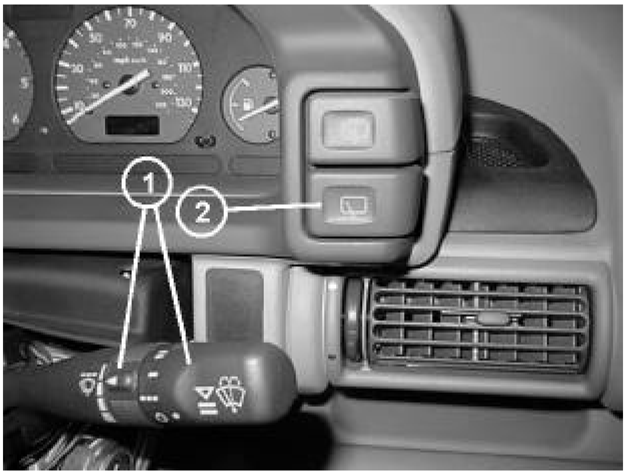
Removing The Roof

The way in which the CCU controls the operation of the tail door drop glass is influenced by the state of the roof switch. The roof switch is located D post and informs the CCU if the roof is fitted or removed. The switch is open circuit when the roof is fitted. The switch will also inform the CCU if when the roof is folded, on vehicles fitted with a fabric roof. The roof switch influences the tail door drop glass operation as it is undesirable that a vehicle is driven with the window in the up position, i.e. closed, when the vehicle is driven with the roof removed or folded. Therefore, whenever the CCU detects the roof is removed, it will drive the tail door drop glass to the fully open position and suspend further operation of the drop glass until the roof is refitted. Whenever the door is open, where the roof is not fitted, or where the roof is folded, the CCU will not allow the tail door drop glass to drive up to the closed position.

Wipers - Operation

The front wiper system comprises a wiper motor, linkage, switch assembly and electrical circuit. The system also incorporates the front screen wash components. The CCU controls the operation of the front wipers in response to requests received from the wiper switch.

The front wipers provide a slow and fast speed function and flick wipe feature, as well as a programmed wash-wipe facility and a variable delay intermittent mode. All Freelander derivatives fitted with a tail door drop glass feature a heated rear window and tail wiper. Like the operation of the front wipers, the operation of the tail wiper is also controlled by the CCU.



1. Front wiper switch
2. Tail wiper switch

Figure 12

The tail wiper will operate in a slow mode, intermittent mode and a programmed mode. The precise operating mode will be determined by the CCU which monitors input signals from the ignition switch, wiper switch, wash switch, reverse gear switch, tail wiper park sense, tail door drop glass position and roof switch.

The tail wiper system comprises a motor, wiring and tail wiper switch. In addition, it incorporates the tail door drop glass wash components. As shown in the illustration above, the wash switch is located adjacent to the tail wiper switch on the right hand side of the instrument binnacle.

Engines and Engine Management

K Series Engine Introduction

The K Series engine was launched in 1989 and has become widely acknowledged as an industry leader in terms of innovative design, and consistent reliability.

The engine is built up from aluminium castings bolted together. These consist of three major castings, the cylinder head, cylinder block and bearing ladder which is line bored to provide the main bearing bores. Attached to these are three minor castings. Above the cylinder head is the camshaft carrier and the camshaft cover, and below the bearing ladder is an oil rail.

Each of the ten cylinder head bolts pass through the cylinder head, cylinder block and bearing ladder to screw into the oil rail. This puts the cylinder head, cylinder block and bearing ladder into compression with all the tensile loads being carried by the cylinder head bolts. When the cylinder head bolts are removed, additional fixings are used to retain the bearing ladder to the cylinder block and the oil rail to the bearing ladder.

The cross flow cylinder head has four valves per cylinder, and central spark plug combustion chamber arrangement. The inlet ports are designed to induce swirl and control the speed of the induction charge. This serves to improve combustion and hence fuel economy. Performance is also increased, with a reduction in exhaust emissions. Self adjusting hydraulic tappets are fitted on top of each valve and are operated directly by the camshafts.

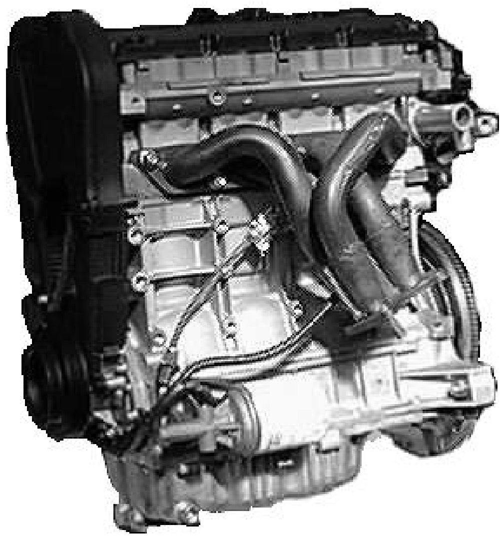


Figure 13

Engine General Data

Engine Designation (No Air Conditioning)	18K4FJ78
Engine Designation (With Air Conditioning)	18K4FJ79
Model Type	K Series
Number of Cylinders	4
Valves Per Cylinder	4
Valve Actuation	DOHC
Bore	80mm
Stroke	89.3mm
Capacity	1796cc
Compression Ratio	10.5:1
Maximum Power	120PS @5500rpm
Maximum Torque	161Nm @ 4500rpm

L Series Diesel Engine

The L Series engine is a four cylinder, two valve per cylinder direct injection diesel engine with electronically controlled fuel injection.

The engine features a cast iron cylinder block with aluminium alloy cylinder head and cast alloy sump. The cylinder block incorporates direct bored, Siamese bores to provide a rigid structure and to also reduce engine length. A cast iron crankshaft has four balance weights and cold rolled journals. Crankshaft end float is controlled via four thrust washers at the centre main bearing. The oil pump is driven via a woodruff key on the front end of the crankshaft. The flywheel is secured to the rear of the crankshaft via 8 micro-encapsulated bolts. The flywheel also incorporates a hole for a timing pin when the pump timing is being checked or adjusted. An additional four drillings on the inner face of the flywheel provide information on crankshaft position to the ECM via the crankshaft position sensor.

The cylinder head has a single camshaft which runs in line-bored bearings formed by the head and the camshaft carrier. The camshaft is driven by a single toothed belt, and operates two valves per cylinder via hydraulic tappets. Oil supply to the camshafts and the hydraulic tappets is fed from a full length oil way in the cylinder head and individual drillings.

The toothed camshaft belt is tensioned by a semi automatic tensioner which can be withdrawn using a special tool for cambelt servicing.

An electronically controlled fuel injection pump is located to the front of the engine and is driven by the camshaft toothed belt. An externally mounted water pump is driven from the rear of the power steering pump . A brake system exhauster is fitted to the front of the alternator. Both the power steering pump and the alternator are driven by the auxiliary belt whose tension is controlled by a fully automatic spring loaded tensioner.

Engine General Data

Engine Designation (No Air Conditioning)	17N
Engine Designation (With Air Conditioning)	18N
Model Type	L Series
Number of Cylinders	4
Valves Per Cylinder	2
Valve Actuation	SOHC
Bore	84.5 mm
Stroke	88.9 mm
Capacity	1994 cc
Compression Ratio	19.5:1
Maximum Power	97.4 PS @ 4200 RPM
Maximum Torque	210 Nm @ 2000 RPM

Fracture Split Connecting Rods

Aluminium alloy pistons fitted with a conventional piston ring set-up are connected to forged steel connecting rods with wedge shaped small end bearings, and fully floating gudgeon pins.

A unique feature on the L Series application used in Freelander vehicles is the use of “fracture split” connecting rods. The term fracture split connecting rod refers to the way the big end cap is separated from the connecting rod.

In other Land Rover engines, the connecting rod and cap are forged in one piece and are separated by machining the big end bearing cap from the connecting rod. This results in material wastage and the need for precision grinding of the mating surfaces. In the fracture splitting process, the connecting rod and big end bearing cap are designed to separate close to the theoretical centre line with no loss of material. This is achieved by applying a load between the big end bearing cap and connecting rod via a wedge in a split mandrel. The big end bore in the connecting rod is pre-machined with a notch introduced at the required joint plane to initiate the fracture. The separation is accurately determined by careful consideration of the geometry of the forging and material selection. Fracturing of the connecting rod takes place immediately before the bolts are fitted and correctly tightened, this keeps the matching cap and rod together for subsequent finish machining of the bore. After fracturing, the surfaces form a unique “multifaceted” joint which provides a contact area much greater than that of a normally ground surface. The multifaceted joint also promotes precise mating between the big end bearing cap and connecting rod. No further machining of the faces is required, and no additional means of big end bearing to connecting rod location is necessary.

Figure 14

The main benefits of this process are as follows:

- Manufacturing time and costs are reduced.
- Each connecting rod and big end bearing cap has a unique fracture, this reduces the possibility of a big end bearing cap being fitted to an unmatched connecting rod.

Electronic Diesel Control

An electronically controlled Engine Management System (EMS), is fitted to all Freelander derivatives equipped with a diesel engine. It's function is to control engine fuelling. The system is designed to maximise performance and ensure the desired emission control is achieved throughout all driving conditions.

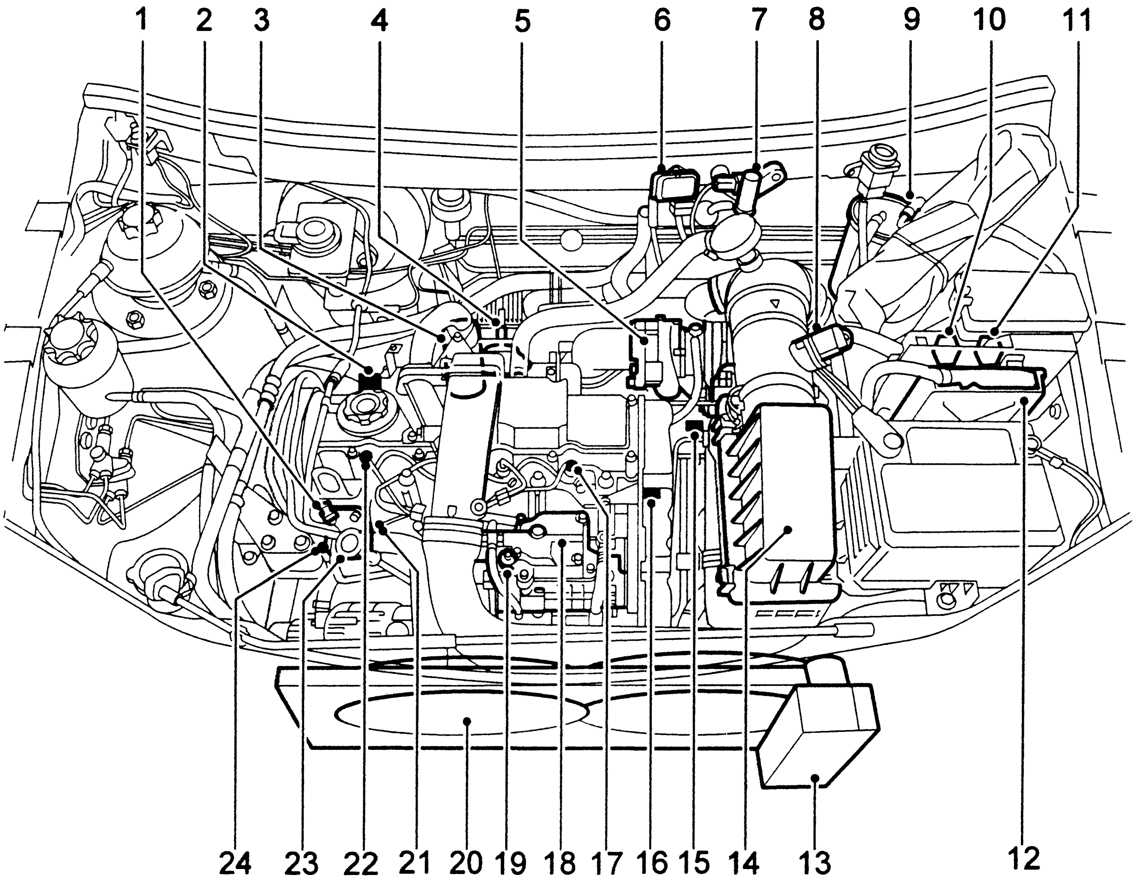
The system is referred to as Electronic Diesel Control (EDC). EDC has been previously employed on Land Rover Discovery derivatives equipped with the 300 Tdi engine. With the exception of a number of relatively minor features, the functionality of the EDC system fitted to Freelander derivatives is identical to that of the Discovery system. The system has been programmed to ensure it is suited to the fuelling requirements of the Freelander vehicles.

The system incorporates the following key features:

- *Distributor Type Fuel Injection Pump*
- *Electronically Timed Injection*
- *Electronically Controlled Fuel Quantity*
- *Electronically Controlled Exhaust Gas Recirculation*
- *Fault Detection, Storage and Back-up Facility*
- *System Fault Diagnosis Support*
- *Electronic Engine Immobilisation*
- *Communication For Hill Descent Control*

Component Location

The illustration below shows the engine compartment of vehicles fitted with the diesel engine and shows the installed location of a selected number of components incorporated into the EDC system.



1. ECT Sensor
2. IAT Sensor
3. EGR Cooler
4. EGR Valve
5. Turbocharger
6. MAP Sensor
7. EGR Modulator Valve
8. MAF Sensor
9. Fuel Filter
10. Main Relay
11. Glow Plug Relay
12. ECM
13. Intercooler
14. Air Cleaner
15. Vehicle Speed Sensor
16. CKP Sensor
17. Injectors
18. Fuel Injection Pump
19. Fuel Shut Off Solenoid
20. A/C Condensor Fan
21. Glow Plugs
22. Needle Lift Sensor
23. Coolant Elbow
24. ECT Sender (Gauge)

Figure 15

Inputs & Outputs

The EDC system incorporates an Engine Control Module (ECM). This unit ultimately determines the quantity of the fuel injected into the engine and the precise timing of injection. The ECM is connected to a number of sensors located on and around the engine. These sensors supply input signals to the ECM relating to engine running conditions. The signals supplied are used by the ECM to determine various outputs. The following provides a brief description of each input and output.

INPUTS	ECM	OUTPUTS
CKP Sensor (Crankshaft Position) *Enables the ECM to calculate engine position, signal frequency proportional to engine speed.*		Fuel Shut-off Solenoid *The ECM controls the Fuel Shut-off Solenoid which will either allow or disallow fuel supply.*
MAP Sensor (Manifold Absolute) *Converts pressure signal into electrical value. Used by ECM (in conjunction with CKP and IAT signals) to calculate engine load.*		Fuel Injection Timing Device *The ECM continually modulates the solenoid, advancing and retarding the injection timing to achieve the optimum timing position.*
IAT Sensor (Inlet Air Temperature) *Voltage signal varies with the temperature of the intake air. Used together with MAP Sensor signal to calculate density of air entering engine.*		Fuel Quantity Control Servo *The ECM activates the Fuel Quantity Control Solenoid to ensure the correct amount of fuel is delivered to the injectors.*
MAF Sensor (Mass Air Flow) *This signal informs the ECM of the quantity of air entering the engine.*		Glow Plug Relay *ECM provides a ground connection to the Glow Plug Relay in order to control power supply to Glow Plugs*
ECT Sensor (Engine Coolant) *Voltage signal varies with engine coolant temperature, enables engine to calculate coolant temperature.*		Glow Plug Lamp *The ECM will illuminate this lamp when the glow plugs are powered.*
TP Sensor (Throttle Position) *Variable voltage signal, proportional to throttle opening. Enables ECM to calculate rate of throttle movement.*		EGR Modulator Valve *The EGR modulator valve is activated (modulated) by the ECM when it determines exhaust gas recirculation should take place.*
Vehicle Speed Signal *This signal is proportional to the vehicle speed.*		
Injector Needle Lift Sensor *ECM uses this signal to reference the start of injection point*		ABS ECU *The ECM provides a multiplexed signal incorporating an engine identifier signal, throttle position signal, engine speed signal and an engine torque signal to enable the ABS ECU to correctly control the HDC and ETC system*
Fuel Temperature Sensor *This signal is used by the ECM to calculate fuel density and influences the quantity delivered..*		
Fuel Quantity Servo Potentiometer *This signal is used by the ECM to calculate the quantity of fuel delivered.*		Engine Warning Lamp *The ECM provides a controlled connection to ground to illuminate the Engine Warning Lamp*
Brake Switch *This input enables the ECM to determine when the foot brake is applied*		Main Relay *The ECM provides a ground connection to the relay coil winding in response to receiving an Ignition Switch Signal input.*
Battery Supply *Power to ECM. (Also used in calculations for injector duration and ignition dwell period).*		
Ignition Switch Signal *Battery voltage signal when ignition turned to position I. Enables ECM to calculate when ignition switched on and off.*		Grant Air Conditioning *The ECM provides a controlled ground to operate air conditioning/cooling fans in the desired state. The state will depend upon inputs received from the Ignition Switch, ECT Sensor and TP Sensor*
Earth Supply *Connects ECM to vehicle ground.*		
Diagnostic Input *Enables communication between ECM and TestBook.*		Cooling Fan Relay *The ECM provides a controlled ground connection to energise the cooling fan relay in response to the engine coolant temperature signal*
Air Conditioning Request *ECM in series with air conditioning trinary switch. Enables ECM to sense air conditioning request*		
Central Control Unit *Immobilisation code and state of inertia switch.*		Diagnostic Connector *Enables communication between the ECM and TestBook*

Petrol Engine Management System

An electronically controlled Engine Management System (EMS), is fitted to all Freelander derivatives equipped with a petrol engine. It's function is to control both engine fuelling and ignition timing to ensure that an optimum level performance and efficiency is achieved throughout all driving conditions.

The Engine Management System fitted to Freelander derivatives is MEMS (Modular Engine Management System). MEMS was originally introduced on Rover Group products in 1989. Since it's introduction, it has been continuously refined and developed to ensure it continues to meet current and future legislative and design requirements.

Several different configurations of MEMS have been fitted to Rover Group products over the years. The different configurations can be identified by their "version" number. MEMS version 1.6 is fitted to Land Rover Discovery Mpi vehicles. MEMS version 1.9 is fitted to Freelander derivatives.

Although MEMS version 1.9 fitted to Freelander derivatives is configured with a unique tune to suit the vehicle's specific characteristics, it continues to use many of the features standard to the version of MEMS fitted to Discovery vehicles.

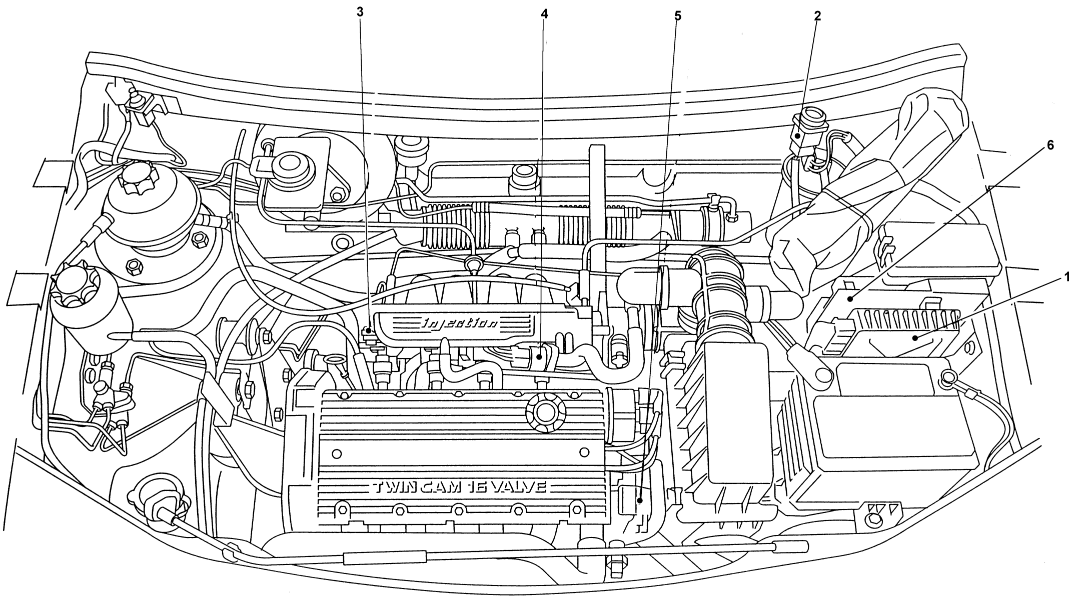
- *It utilises a single ECM (Engine Control Module), to control engine management functions.*
- *It calculates the basic air/fuel ratio using the speed/density method*.
- *It controls the engine idle speed.*
- *It controls the ignition timing.*
- *It makes instantaneous adjustments to the air/fuel ratio to suit the specific driving conditions.*
- *It has a diagnostic monitoring function, designed to identify and store details of certain EMS faults.*

In addition to the functions detailed above, MEMS version 1.9, as fitted to Freelander derivatives, incorporates a number of supplementary features. These have been added to the specification of the system to ensure the aspirational performance and refinement objectives are met.

- *It supports a returnless fuel delivery system.*
- *It communicates with the CCU to support the immobilisation feature*.
- *It communicates with the brake system ECU to support HDC.*
- *It controls activation of the cooling fan motors and air conditioning compressor.*

Petrol Engine Management System- Component Location

The following illustration shows the installed location of a selected number of components incorporated into the engine management system.



1. MEMS ECM
2. Inertia Switch
3. Fuel Rail Damper
4. IACV
5. Ignition Coil
6. Relay Units

Figure 16

Communication between the MEMS ECM and TestBook can be achieved by way of the 16 way diagnostic connector located in the front passenger footwell (as shown previously). The location of the diagnostic connector changes with the drive hand of the vehicle, i.e. opposite side to the steering hand.

Petrol Engine Management System - Inputs & Outputs

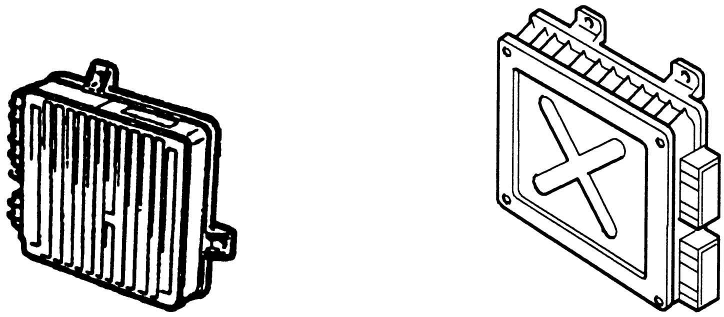
As mentioned, the MEMS 1.9 engine management system fitted to Freelander petrol derivatives, shares many similarities with the MEMS 1.6 system fitted to Mpi Discovery vehicles. The following table details the various inputs and outputs received and supplied by the MEMS 1.9 ECM.

INPUTS	ECM	OUTPUTS
CKP Sensor (Crankshaft Position) *Enables the ECM to calculate engine position from “missing pole.” Variable signal, frequency proportional to engine speed.*		Injectors *The ECM provides a controlled vehicle ground connection to the injectors. Controlling its duration to determine the amount of fuel injected.*
MAP Sensor (Manifold Absolute) *Converts pressure signal into electrical value enabling ECM to calculate engine load.*		Ignition Coil *The ECM provides a timed controlled vehicle ground connection to the ignition coil..*
ECT Sensor (Engine Coolant) *Voltage signal varies with engine coolant temperature, enables engine to calculate coolant temperature.*		Idle Air Control Valve *The ECM provides controlled vehicle ground connections to determine the position of the IACV, to control engine idle speed.*
IAT Sensor (Inlet Air Temperature) *Voltage signal varies with the temperature of the intake air. Used together with MAP Sensor signal to calculate density of air entering engine.*		Main Relay *The ECM provides a vehicle ground connection to the coil winding in response to receiving an Ignition Switch Signal input.*
HO2S Sensor (Heated Oxygen) *Voltage signal proportional to the quantity of Oxygen in the exhaust gas. Enables the ECM to calculate air/fuel mixture.*		HO2S Relay *The ECM provides a controlled vehicle ground connection to the coil winding to energise the relay when the ignition is switched on.*
TP Sensor (Throttle Position) *Variable voltage signal, proportional to throttle opening. Enables ECM to calculate rate of throttle movement.*		Fuel Pump Relay *The ECM provides a controlled vehicle ground connection to the coil winding for 2 seconds when Ignition Switch Signal is received, when the engine is cranked and whenever the engine is running.*
Diagnostic Input *Enables communication between ECM and TestBook.*		Diagnostic Connector *Enables communication between the ECM and TestBook.*
Battery Supply *Power to ECM.*		Cooling Fan Relay *The ECM provides a controlled vehicle ground connection to energise the cooling fan relay in response to the engine coolant temperature signal.*
Ignition Switch Signal *Battery voltage signal when ignition turned to position I. Enables ECM to calculate when ignition switched on and off.*		ABS ECU *The ECM provides a multiplexed signal incorporating an engine identifier signal, throttle position signal, engine speed signal and an engine torque signal to enable the ABS ECU to correctly control the HDC system.*
Earth Supply *Connects ECM to vehicle ground.*		Sensor Feed *The ECM supplies a 5 volt supply to the TP Sensor, ECT Sensor and the IAT Sensor.*
Select Air Conditioning *ECM in series with air conditioning trinary switch. Enables ECM to sense air conditioning request.*		Grant Air Conditioning *The ECM provides a controlled ground to operate air conditioning/cooling fans in the desired state. The state will depend upon inputs received from the Ignition Switch, ECT Sensor and TP Sensor*
Central Control Unit *Immobilisation code and state of inertia switch.*		MIL (Malfunction Indicator Lamp) *The ECM provides a controlled connection to vehicle ground to illuminate the MIL*

Petrol Engine Management System - Features

The following text outlines the significant differences between the MEMS 1.9 system fitted to Freelander applications and the MEMS 1.6 version fitted to Discovery Mpi applications.

ECM (Engine Control Module)

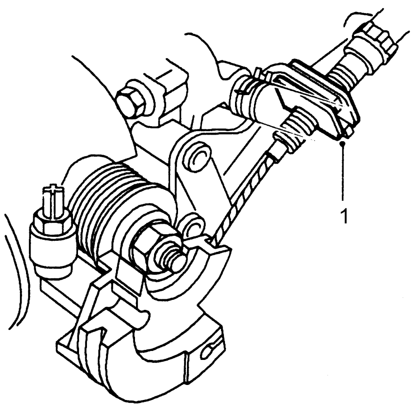


MEMS 1.6 MEMS 1.9

Figure 17

In addition to the MEMS 1.9 ECM incorporating different internal circuitry and programming, it also features a completely different external appearance. As shown in the illustration above, the MEMS 1.6 ECM features a cast casing and ribbed cast cover. Whereas the MEMS 1.9 ECM features a ribbed cast casing and a pressed aluminium cover. These obvious external differences assist unit identification.

Throttle Cable Fixing

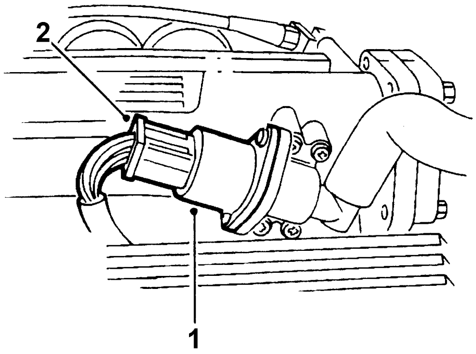


1. Moulded Adjustment Nut.

Figure 18

The throttle cable is secured to the throttle body by way of a pressed steel abutment bracket and moulded adjusting nut, see the illustration above. The moulded adjustment nut, locks into the abutment bracket by way of an interference fit. Throttle cable free play is easily adjusted and does not require the use of spanners.

IACV (Idle Air Control Valve)



1. IACV
2. Connector

Figure 19

In Freelander applications MEMS provides full control over the engine idle speed. It primarily does this by varying the amount of air which is permitted to by-pass the throttle valve. In operation, the MEMS ECM monitors several input signals and then uses its pre-programmed strategy to calculate and then set the position of the valve to achieve the desired engine speed. There is no facility and there should be no requirement to adjust the engine idle speed in service. However, it is possible to check and if necessary reset the position of the IACV using TestBook.

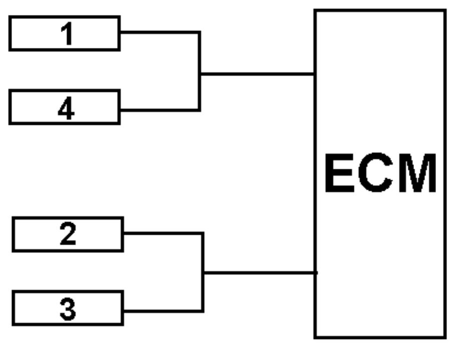
Redesigned Reluctor

As detailed previously, the MEMS ECM receives an engine speed and position signal from the CKP sensor. This sensor is of an inductive type and is secured to the engine back plate. The sensor protrudes through the back plate and "reads" from a reluctor incorporated into the flywheel. The reluctor is machined into the flywheel and comprises 32 pairs of "poles" spaced at 10^{o} intervals. 4 pairs of poles are removed. The missing poles are used by the MEMS ECM to identify engine position, i.e. when number 1 cylinder is at TDC. The MEMS ECM is unable to calculate the firing position of the engine from the signal received from the CKP sensor.

Flywheel

Figure 20

Grouped Injector Strategy



1-4 Grouped Injectors

Figure 21

Multipoint fuel injection is supported by MEMS in Freelander applications. The system features one injector per cylinder, i.e. 4 injectors total. The injectors are paired in two groups, i.e. injectors for number 1 and 4 cylinders form one group and the injectors for number 2 and 3 cylinders form a second group. The injectors are wired in parallel, see illustration above. MEMS operates the injectors in a combination of banked and grouped strategies.

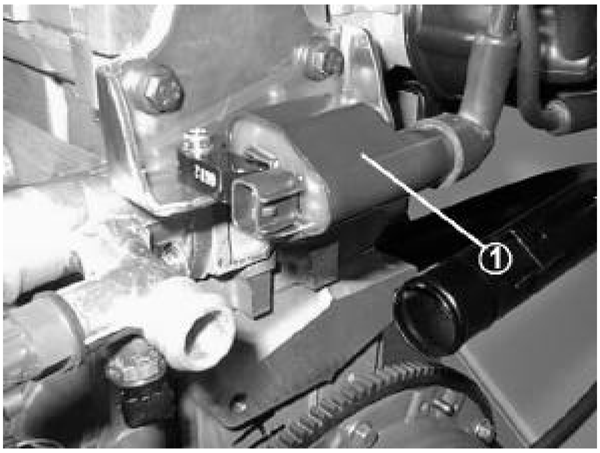
The ECM actuates the injectors by providing an vehicle ground connection. The specific timing and duration of the connection to ground will determine precisely when the injector opens and how long the injector is open for. Therefore the ECM is able to determine the quantity of fuel injected and control it accordingly.

At engine speeds of 400 rpm and below (i.e. when cranking), the ECM will actuate all four injectors simultaneously. At this time the injectors will be actuated every 180^{o} of crankshaft movement.

When the engine speed increases above 400 rpm the ECM will initiate its grouped strategy. At this time the ECM will actuate the injectors in pairs. Each pair will be actuated at approximately 140^{o} BTDC on respective cylinder groups, every 720^{o} of crankshaft movement.

Distributed Ignition

Unlike the MEMS 1.6 system fitted to Discovery Mpi vehicles, which uses distributorless ignition, where HT sparks are passed directly to the spark plugs from double ended ignition coils, the MEMS 1.9 system uses a single coil and a rotor arm and distributor cap assembly to distribute the HT sparks to the spark plugs.



1. Coil

Figure 22

As shown in the illustration above, the ignition coil is secured to a pressed steel bracket located at the right hand end of the engine, adjacent to the distributor. The rotor arm secures to a shaft pressed into the inlet camshaft.

Returnless Fuel System

Freelander petrol vehicles are fitted with a returnless fuel system. The system comprises a fuel tank (60 litres capacity 13.2 gallons), fuel pump assembly mounted in the fuel tank (incorporating the pump, pressure regulator and swirl pot), single fuel supply line, fuel rail and pressure damper.

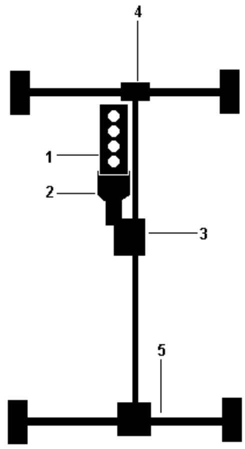
Fuel is drawn from the tank by the fuel pump and delivered to the fuel rail located on the engine. The regulator, located in the pump assembly, regulates system pressure to 3.5 bar. Unlike the fuel system fitted to Discovery Mpi vehicles, which incorporates a return line and a regulator designed to make adjustments to the fuel system pressure to compensate for changes in intake manifold pressure, this pressure of 3.5 bar is constant and does not change at any time. The MEMS 1.9 ECM makes adjustments to injector duration to compensate for changes in manifold pressure to maintain the desired air/fuel ratio in all conditions.

Figure 23

A fuel pressure damper (as shown above), is fitted on the fuel rail. It is fitted in place of the conventional fuel pressure regulator. The damper serves to dampen out variations in pressure generated by normal operation of the fuel pump. It is connected to the intake manifold by way of a rubber hose. This serves no purpose and does not influence the dampening effect. However, it must remain connected at all times to prevent an intake manifold air leak.

Drivetrain

Ever since the successful introduction of the first Land Rover in 1948, all mass produced vehicles designed and built by the company, have shared a “common” driveline configuration, i.e. engine, gearbox and axle layout. In addition, all these vehicles have featured permanent four wheel drive. The schematic below shows a conventional Land Rover driveline layout.



Land Rover driveline layout

1. Engine
2. Gearbox
3. Transfer Gearbox
4. Front Axle (solid)
5. Rear Axle (solid)

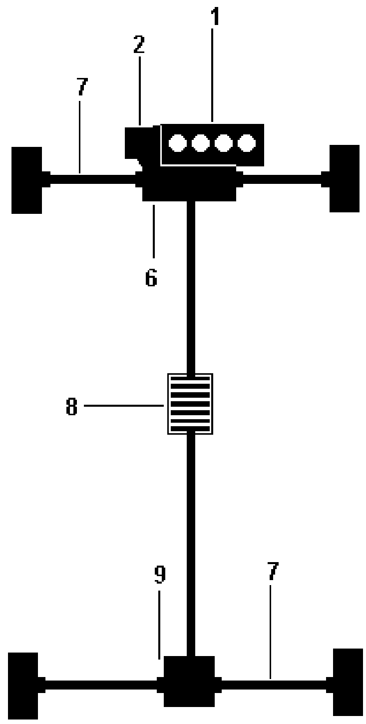
Figure 24

In the conventional driveline layout, a longitudinally mounted engine, i.e. an engine mounted along the length of the vehicle, is bolted to a transmission, which is also longitudinally mounted. A transfer gearbox is located to the rear of the transmission. Drive from the engine passes through the transmission to the transfer gearbox. From the transfer gearbox the drive is delivered to the front and rear axles.

Some earlier Land Rover applications, (e.g. Land Rover derivatives and Range Rovers built up to 1982) used transmission assemblies which incorporated an integral transfer gear arrangement. Later Land Rover applications feature separate units, i.e. a separate transfer gearbox bolted to the main transmission, as shown in the schematic.

The transfer gearbox (or previously used integral transfer gear arrangement), serves three main purposes. Firstly, it enables drive to be delivered to the front and rear axles (so providing four wheel drive). Secondly, it incorporates a differential to control the proportion of drive delivered to each axle (to maintain optimum on-road and off-road performance). Thirdly, it houses two sets of gears and enables the driver to select from two different drive ratios (High or Low range). This feature increases the vehicles flexibility of use and enhances its ability to perform well both on-road and extreme conditions off-road.

As with many of it’s other features, Freelander challenges convention and departs from the Land Rover “norm.” Some considerable changes have been made to the vehicle’s driveline to satisfy the design criteria and meet the performance aspirations. The choice of engines has been a major factor in determining the layout used. The schematic below shows the Freelander driveline layout.



Freelander driveline layout

1. Engine.	7. Driveshafts.
2. Gearbox.	8. Viscous Coupling.
6. IRD.	9. Differential.

Figure 25

Instead of the engine being mounted longitudinally in the Freelander application, the engines are mounted transversely, i.e. across the vehicle. This design necessitates the fitment of a transversely mounted transmission. A conventional transfer gearbox design is not suited to this layout. Therefore, to facilitate the delivery of permanent four wheel drive to the front and rear axles, and to ensure the drive is delivered at a suitable ratio, an IRD (Intermediate Reduction Drive) unit is fitted.

As shown in the schematic, the IRD is fitted in place of a conventional transfer gearbox. It is attached to the transmission and controls the distribution of drive to the front and rear wheels. The IRD incorporates a differential unit to control the proportion of drive delivered to each of the front wheels. The IRD delivers drive at a single fixed ratio. In addition it works in conjunction with the viscous coupling to give Freelander vehicles a self-sensing four-wheel drive system, which ensures the distribution of torque, to the front and rear wheels, is continuously optimised.

The IRD unit fitted to all Freelander derivatives is designed and assembled by SFT (Steya-Daimler-Puch Farzeugtechnik) of Austria. The following illustration shows the IRD unit. The unit comprises: A main casing, a primary gear shaft, a differential, an intermediate shaft, a right hand casing, a layshaft, a hypoid gear, a rear output pinion, a pinion casing and a coolant to oil heat exchanger.

IRD unit

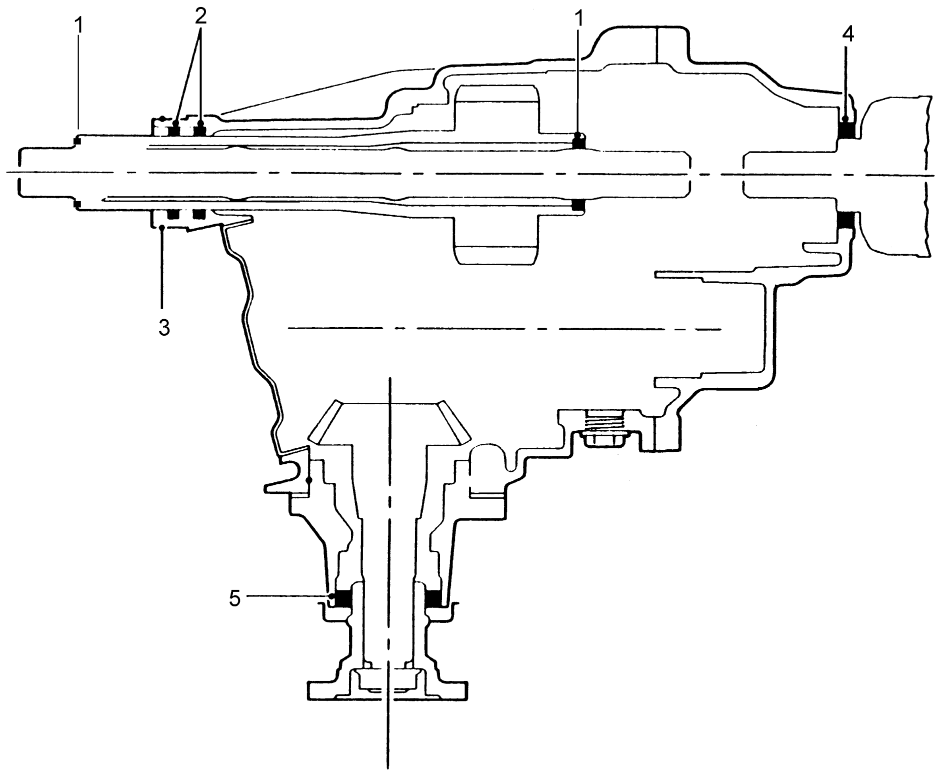
Figure 26

In addition to the main components as listed above, the IRD houses seven taper roller bearings, a parallel roller bearing, six oil seals, two “O” rings, a snap ring, a circlip, a collapsible spacer and 18) four selectable steel shims.

The main casing, the right cover and the pinion housing of the IRD are all manufactured of cast aluminium. The primary gear shaft, intermediate shaft, differential gear gears, layshaft, hypoid gear assembly, pinion and rear drive flange are all made of forged or bar steel. The hypoid gear and the pinion gear are designed as a matched pairing. The primary gear, laygear and front differential crown wheel gear all feature a helical gear profile.

The IRD has an oil capacity of 1.1 litres and uses Texaco Geartex S5 75W-90. The IRD unit is “filled for life” and does not require routine oil changes, although the oil level must be maintained as per the published service schedule. The IRD main casing incorporates an oil drain plug and an oil filler/level plug The oil used within the IRD unit differs from that used within the PG1 transmission, and must not be allowed to mix. Therefore, the design prevents oil passing from one unit to another.

The following illustration shows the location of the various seals and “O” rings, and describes the function of each one.

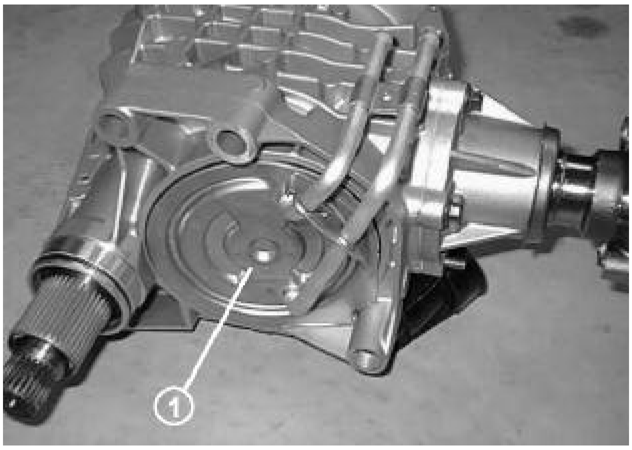


Seals and “O” rings

1. Intermediate shaft to primary gear shaft - Seals
2. Primary gear shaft to casing. - Seals
3. IRD casing to PG1 assembly - O Ring
4. RH Driveshaft to IRD casing - Seal
5. Pinion output shaft housing - Seal

Figure 27

An oil to coolant heat exchanger (oil cooler) is installed into the main casing of the IRD. This unit serves to control the operating temperature of the IRD oil in high ambient temperatures, arduous conditions and in conditions where the vehilce is driven at high speeds. The following illustration shows the installed position of the oil cooler.



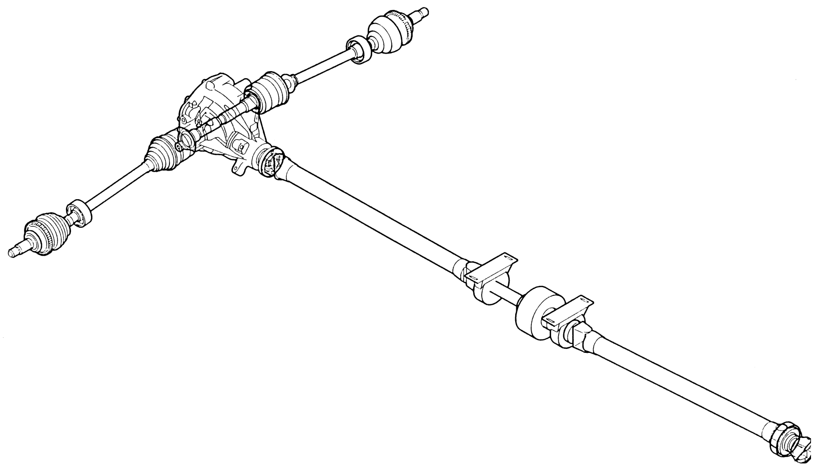
1. Oil cooler

Figure 28

The cooler is made of aluminium. It is designed to lower the operating temperature of the IRD oil by transferring heat from the oil to engine coolant, which circulates around the cooler body. The cooler is sealed to the IRD main casing by way of a rubber seal which fits around its circumference. This seal also serves to secure the oil cooler in its installed position. It is not possible to remove the oil cooler from this position without causing it irreparable damage. The diameter of the two coolant pipes incorporated onto the cooler differ. This deliberate design feature prevents incorrect fitment of the feed and return hoses.

Propeller Shaft Assemblies

Drive to the rear wheels is supplied from the IRD unit, via the “GI” constant velocity joint to the front prop shaft. The front prop shaft connects to the VCU (Viscous Coupling Unit) which is itself connected to the rear prop shaft. Drive is transferred from the rear prop shaft to the differential unit and from the differential to the rear drive shafts. The illustration below shows the components involved in the distribution of drive to the rear wheels.



Rear wheel drive line layout.

Figure 29

The GI joint is incorporated into the front prop shaft by way of a welded joint. Iot is secured to the rear drive flange of the IRD unit by way of six Torx headed bolts. It provides a constant velocity connection between the two units and serves to de-couple all high frequency vibrations to minimise the transmission of NVH (Noise/Vibration/Harshness). In addition, the GI joint allows for up to 51 mm of axial plunge (in other words flexible in and out movement). This movement serves to maintain the delivery of drive in all conditions and accommodate for engine movement caused by torque reaction. The GI joint is sealed for life and is not serviceable separately from the front prop shaft.

1. The GI joint

Figure 30

The front prop shaft connects the IRD unit rear output drive flange (via the GI joint), to the VCU assembly. The prop shaft houses the GI joint at the forward end, as already described. It is approximately 570 mm in length and 63 mm in diameter. It incorporates a conventional “Spicer” type universal joint at the rear and is secured to the VCU shaft by way of a nut.

To prevent the front prop shaft amplifying NVH, two cardboard dampers are pressed into the tubular section of the shaft during the manufacturing procedure. The front prop shaft can be serviced as an assembly separate from the rest of the driveline. The universal joint can be serviced separately if required. The following illustration shows the front prop shaft universal joint and VCU, together with the damper and centre bearing assemblies.

Rear of the front prop together with the VCU and bearings.

Figure 31

Two centre bearing assemblies (see illustration above), are used to support the rear of the front prop shaft, the VCU assembly and front of the rear prop shaft. The bearings also and help to de-couple NVH from the vehicle body. The bearing assemblies are pressed onto the VCU shaft and are bolted to the vehicle’s floor panel. To prevent accelerated wear, the bearing assemblies must be secured to the body with care, ensuring perpendicular alignment with the VCU shaft. This should eliminate uneven loading and ensure correct alignment with the prop shafts. The two bearing assemblies are identical, although their installed orientation, i.e. the way round they are fitted, is opposed. The bearings are sealed for life and require no routine maintenance other than visual inspection. The bearings assemblies can be serviced separately from the VCU and prop shafts.

Viscous Coupling

The VCU (Viscous Coupling Unit) is a major component of the driveline. It effectively controls the difference in speed between the front and rear prop shafts and influences the amount of torque distributed to the front and rear differentials. In theoretical terms the rear wheels are 0.8% “under driven” in comparison to the front wheels, however, this figure will change continuously as the vehicle’s speed and dynamics alter.

The VCU is a sealed unit filled with a silicon fluid material. It comprises an input shaft and plates, and an output shaft and plates. The plates fitted to both input and output shafts contain holes through which the silicon fluid is able to pass. The silicon fluid material offers a resistance to shear. Its effective resistance to shear increases as the differential in speed, between the input (i.e. front prop shaft) and output (i.e. rear prop shaft), increases. This characteristic results in the appropriate division of drive torque between the front and the rear differentials to maximise traction in all conditions.

In practice, whenever the front or rear wheels start to spin, the difference in speed between the two prop shaft sections increases. The VCU reacts in these circumstances, as described. It consequently makes it more difficult for the prop shafts to revolve at different speeds and thus delivers a greater proportion of the drive torque to the “non-spinning” differential. The VCU is sealed for life component and does not require any routine maintenance or servicing, over and above visual inspection to its external casing.

In view of the VCU’s operating characteristics, whenever a Freelander vehicle is being towed with either front or rear wheels suspended, an appropriate section of the drive line must be disconnected to isolate the VCU and prevent torque being transmitted from the driven wheels. Similar precautions must be taken when driving the vehicle on a two wheel rolling road, and in any other circumstances where the front or rear wheels are driven independently of each other.

Many measures to prevent the generation, transmission and amplification of NVH are inherent to the design of Freelander. Additional preventative measures have also been taken to minimise NVH issues and increase levels of occupant comfort. One such additional measure is the installation of a torsional damper alongside the VCU. The damper secures, via three patchlock fixings, to a forged flange welded to the VCU shaft. It comprises a pressed steel inner hub and machined outer steel ring. The outer ring is attached to the inner hub by way of a rubber membrane. The damper is serviceable as a complete assembly only. In operation the damper removes any resonance built up in the prop shaft assembly. It achieves this by generating a “resonate phase change,” where the outer ring resonates (cycles/torsionally vibrates) at a different rate to that of the prop shaft assembly.

The rear prop shaft is attached to the rear of the VCU shaft. It is manufactured from smaller diameter tube (approximately 50 mm diameter), than the front prop shaft section. The rear prop shaft does not require and therefore does not incorporate any cardboard dampers. Conventional “Spicer” universal joints are fitted to each end of the rear prop shaft and are serviceable.

Differential

The rear differential assembly serves to convert the “angle of drive” through ninety degrees and distribute drive, in the desired proportions, to both rear wheels. The unit fitted to Freelander derivatives is an integral carrier housing hypoid-gear type, supplied by the DANA Corporation. The rear differential assembly is secured to the rear subframe assembly by way of three rubber bushed mountings. The following illustration shows the installed location of the rear differential assembly.

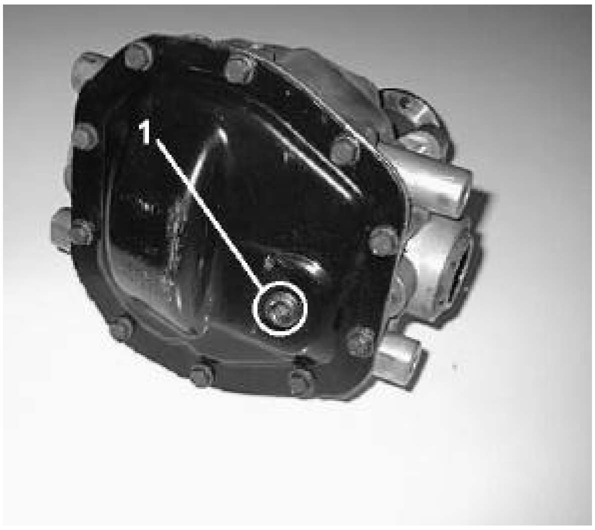
The differential housing is made of aluminium to minimise weight. The housing incorporates the drive pinion gear shaft, which is supported by two opposed tapered roller bearings and cups, and the differential case and ring gear assembly, which is also supported by two opposed tapered roller bearings and cups.

Rear Differential Assembly fitted

Figure 32

The pinion bearing pre-load is controlled by a collapsible spacer (fitted between the two bearings) and the torque applied to the pinion nut. The position of the pinion is controlled by a selective spacer fitted between the inner pinion bearing cone and the pinion gear head.

The differential case assembly is retained in the housing by two removable bearing caps. Shims are located between the differential bearing cones and the differential case in order to control the differential bearing pre-load and ring gear to pinion gear backlash, (i.e. engagement).



1. Level Plug

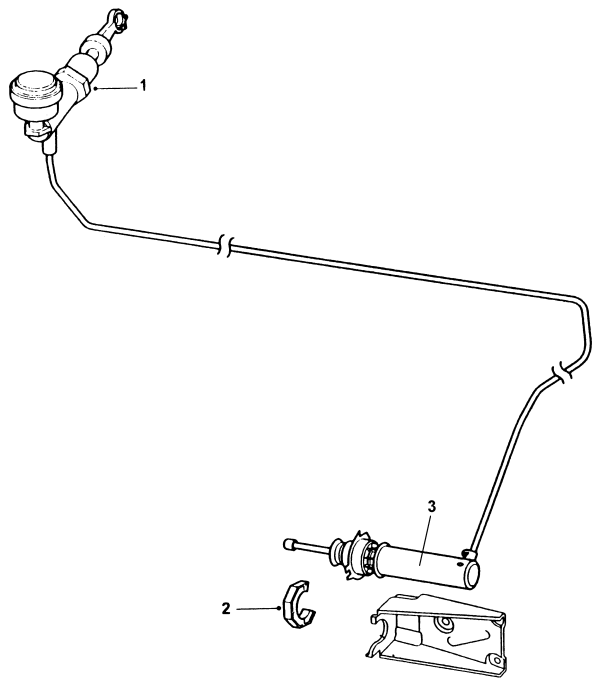
Figure 33

A pressed steel cover is secured to the rear of the differential case by ten fixings. The cover is sealed to the casing with RTV sealant. The cover incorporates a filler plug. The differential is filled for life with Texaco ETL 7441 or equivalent gear oil. The oil level should be maintained to the bottom of the filler plug. The axle has a capacity of approximately 0.8 litres.

A “quick fit” type breather is located in the top of the differential casing to prevent pressurisation of the casing. The pinion is sealed by way of an oil seal, which seats into the differential casing. The seal is referred to as a “labyrinth” type and has been especially designed to prevent contaminant ingress. In this regard, the seal works in conjunction with the pressed steel shield, referred to as a “flinger,” pressed on to the pinion drive flange. The two drive shafts are also sealed by labyrinth type seals pressed into the differential housing.

Clutch System

All Freelander derivatives are fitted with a conventional disc type clutch assembly, designed to facilitate the disengagement of drive between the engine and transmission. The clutch system comprises a cover, drive plate, release bearing (and lever mechanism), hydraulic system (slave cylinder, connecting pipe and master cylinder), and a clutch pedal assembly. The following illustration shows the clutch system layout, as fitted to a right hand drive vehicle.



Clutch. Hydraulic system components (vehicle layout)

1. Master Cylinder. 2. Clip. 3. Slave Cylinder.

Figure 34

The specification of the clutch cover is common to both diesel and petrol derivatives, in other words, the same cover is fitted to all Freelander vehicles. The cover has a 228 mm drive surface diameter and incorporates a diaphragm type spring.

The specification of the clutch drive plate varies according to the type of engine installed in the vehicle, i.e. petrol or diesel. The drive plate fitted to all petrol derivatives is 215 mm in diameter, while the drive plate specified for use in all diesel derivatives is 228 mm in diameter.

It is physically possible to fit either plate in either application. Therefore, care must be taken to ensure the correct drive plate is always fitted. In addition to the difference in diameter, the torsional set-up “tune” of the plates is set differently. This measure ensures the drive plate performance suits the unique characteristics of each application. Also the drive plate is stamped ”fly wheel side” and must be fitted accordingly.

The clutch’s hydraulic system differs considerably from the hydraulic systems fitted to other Land Rover products. The system is a pre-filled low maintenance system which uses proven technology. It is supplied into Land Rover pre-filled, incorporates no bleeding facility and requires no regular maintenance.

The master cylinder is plastic moulded and incorporates an integral fluid reservoir. It is connected to a moulded plastic slave cylinder by a flexible nylon pipe. The master cylinder is secured to the vehicle’s bulkhead by way of a twist and lock mounting configuration. The slave cylinder locates into a bracket on the transmission. The nylon pipe is attached to both components by way of a fastener-free connection.

The clutch system provides several significant advantages such as:

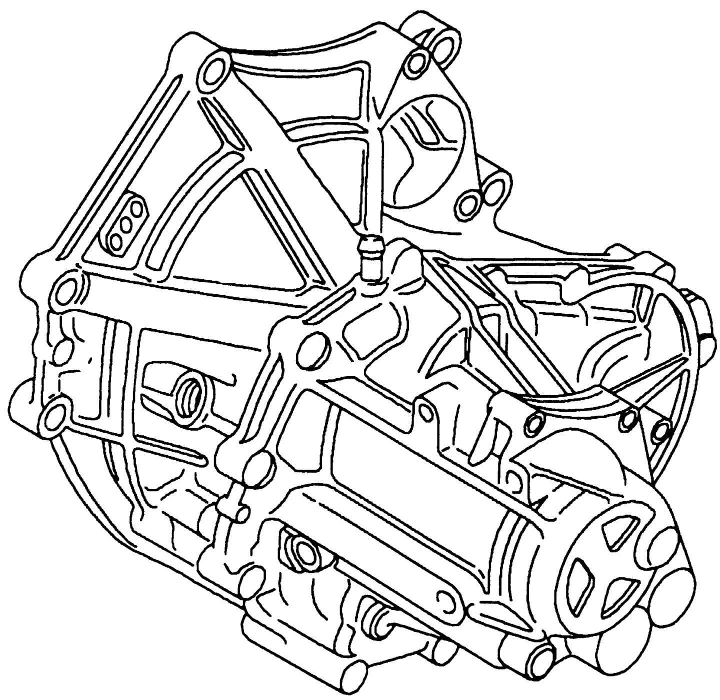
- Improved noise and vibration isolation.
- Consistent, smooth operation in all conditions and temperatures.
- Infinitely variable wear compensation for smooth engagement throughout the life of the clutch and facings.
- Shock load reduction, which protects the drivetrain from torsional shock.
- Light weight.

In service the clutch should require no routine maintenance or adjustment, and unlike other more conventional hydraulic systems, the fluid level does not need to be checked during scheduled services. If a fault with the hydraulic system should occur, then the system must be replaced as a whole, rather than at component level. The replacement system will be supplied pre-filled, and will not require bleeding once fitted.

The slave cylinder is supplied with a “shipping strap” retaining the push-rod into the cylinder. The system is fitted to the vehicle complete with the shipping strap. The first application of the clutch pedal braeks the retaining strap. There is no need to remove the strap prior to assembly, or to manually cut the retaining strap.

Gearbox

All Freelander derivatives, regardless of engine type, are fitted with a five speed constant mesh manual gearbox. This compact unit is mounted transversely and is secured to the engine via an adapter plate. The left hand front drive shaft and the IRD also engage directly to the gearbox.



PG1 gearbox

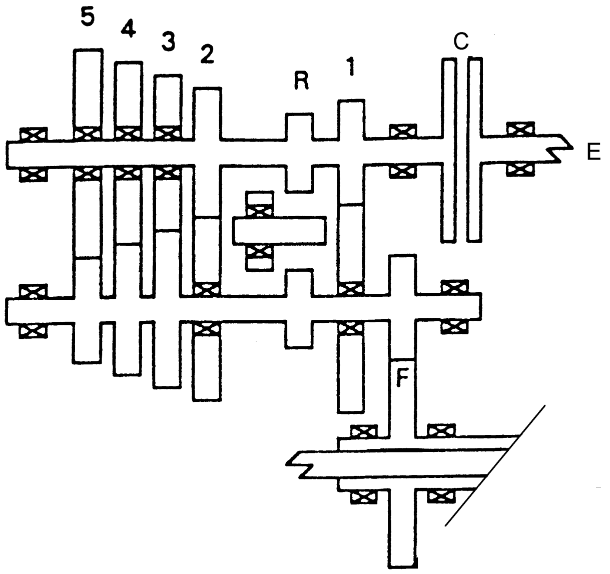
Figure 35

The illustration above shows the gearbox assembly. The unit comprises a two-part cast aluminium main casing, inputshaft, outputshaft, reverse idler gear and shaft, selector mechanism, final drive gear and driveshaft sleeve.

The unit is referred to as a PG1 gearbox. It is based upon a well proven design and is currently fitted to a number of other Rover Group products, (albeit in a slightly different specification). The main differences between the versions fitted in Freelander derivatives and those fitted to other vehicles are:

- Removal of the internal differential, (which on Freelander vehicles has been relocated into the IRD).
- Fitment of a first gear switch, (used in conjunction with the Hill Descent Control system).
- Introduction of a reverse gear brake mechanism (to elimintate “clash” when selecting reverse gear).

The inputshaft, which is connected to the engine via the clutch and transmits drive into the gearbox, features integral 1st, 2nd and reverse gears, (i.e. the gears are part of the shaft). The 3rd, 4th and 5th gears located on the inputshaft rotate on caged needle roller bearings, as shown in the following illustration



Gearbox layout

C. Clutch E. Engine

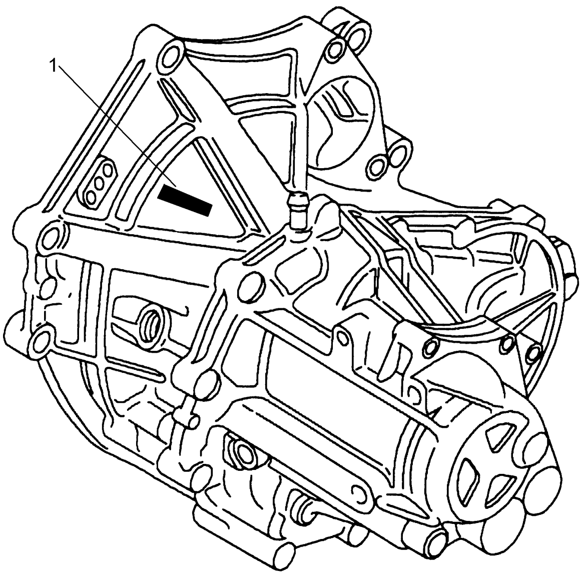
Figure 36

By comparison, the 1st and 2nd gears located on the outputshaft, which accepts drive from the inputshaft and transmits it to the final drive gear, rotate on caged needle roller bearings. The 3rd, 4th and 5th gears are engaged to the outputshaft via a spline. The reverse gear is also splined to the countershaft via the 1st/2nd gear synchro hub assembly. Lastly, the outputshaft incorporates a pinion gear, which transmits drive from the outputshaft to the final drive gear.

As stated above, the pinion gear drives the gearbox final drive gear. The final drive gear is bolted to a carrier assembly which is supported in the gearbox main casing on opposed tapered roller bearings. The tappered roller bearings use “set right” method of bearing pre-load adjustment. A “one size” spacer ring sits behind the left hand side bearing to achieve this. No further shimming is neccessary. A hub/sleeve, incorporating an internal spline, is located within the carrier. This hub/sleeve is supported by two ball bearings which allow it to rotate independently of the carrier.
The left hand front drive shaft engages directly into one side of the sleeve. An integral drive shaft (IRD intermediate shaft), locates into the opposite end of the sleeve. The IRD intermediate shaft connects the left hand front drive shaft with the differential assembly located within the IRD. The gearbox final drive gear is locked to the primary gear shaft of the IRD via the spline. The primary gear shaft serves to transmit drive from the gearbox to the IRD.

Two versions of the PG1 gearbox, each of a slightly different specification, are used in Freelander applications. A “standard” specification unit is fitted in all petrol vehicles, whilst an “uprated” specification unit is fitted in all diesel vehicles.

The specification of a gearbox can be determined by the “gearbox code.” The code is printed onto a white label attached to the gearbox casing. Standard versions of the PG1 gearbox are issued with the following code - S4EM. Uprated versions are issued with the following code - S7EMU.



Location of the gearbox code.

Figure 37

Gearboxes built to an uprated specification feature a larger diameter output shaft bearing land. This necessitates the use of a larger output shaft roller bearing in the gearbox casing. In addition, whereas the standard version of the PG1 gearbox uses two ball bearings to support the opposite end of the output shaft, the uprated version of the gearbox features a combination of one roller bearing and one single race ball bearing. The gear ratios also differ between the two units (see description over page). In all other respects the two versions are identical. The descriptions given here apply equally to both versions unless otherwise stated.

As previously described, the precise specification of the PG1 gearbox changes according to whether the vehicle is fitted with a petrol or a diesel engine.

Standard specification gearboxes used in petrol engine applications feature an outputshaft pinion gear to PG1 final drive gear ratio of 4.2:1. Uprated specification units used in diesel applications feature an outputshaft pinion gear to PG1 final drive gear ratio of 3.64:1. The use of a dedicated ratio ensures that each transmission is suited to the particular characteristics of the engine fitted.

Both standard and uprated versions of the PG1 gearbox feature a reverse brake mechanism integrated with the gear selector mechanism. The brake is designed to eliminate gear "clash" when reverse gear is selected. Clash occurs when gear speeds differ, and engagement is attempted.

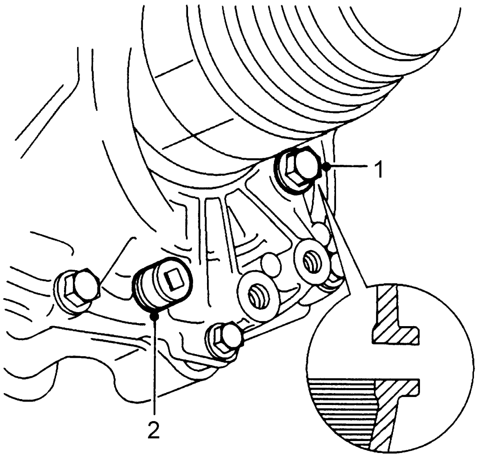
In this application clash is eliminated by partially applying the 4^{th} gear synchromesh during the reverse gear selection procedure. The partial engagement serves as a "friction brake" to eliminate the unwanted gear rotation. With the gear speeds synchronised, clean gear selection can be achieved, providing the vehicle is stationary. The reverse gear brake mechanism requires no additional service maintenance.

First and reverse gear switches

Figure 38

The first gear switch, mentioned previously, screws into the casing and engages with the interlock mechanism. It changes state when first gear is selected. Its primary function is to inform the ABS ECU of first gear selection. The ABS ECU uses this information in its control of HDC, (see separate HDC description). A reverse gear switch is also fitted, to inform the ABS ECU of the engagement of reverse gear. Niether switch is adjustable.

The PG1 gearbox has an oil capacity of 2.2 litres and is filled for life. The oil specified for use within the gearbox is MTF-94. A level plug is located in the main casing adjacent to the output gear. When the gearbox is correctly filled, the oil should be level with the filler plug hole. A drain plug is also located in the casing adjacent to the output gear. The following illustration shows the location of both plugs.



Drain and level plugs

1. Filler Plug 2. Drain Plug

Figure 39

The PG1 gearbox features two oil seals. One oil seal is located in the main casing and is designed to prevent oil leaking into the clutch housing past the input shaft. The second oil seal is located in the main casing and is designed to prevent oil leaking out of the gearbox past the left hand front driveshaft.

When replaced, the new seals should be installed using the recomended special tools. This will ensure the new seals are fitted to the correct “depth” and are square in the casing. They will also prevent damage to the seals during installation.

Softback/Hardback

3-door Freelander derivatives are available in two configurations, one with a folding Softback roof and one with a moulded composite Hardback roof assembly. The availability of the two roof configurations serves to enhance the overall appeal of the vehicle and increases its versatility.

In it's Softback guise, the vehicle features two removable front Targa roof panels and a fabric rear roof assembly. The fabric roof incorporates two removable rear side screens. The roof can be folded forward to allow "open air motoring". In it's Hardback guise, as shown in the following illustration, the vehicle features a moulded composite roof assembly.

Figure 40

The specification of the vehicle will influence the type of roof fitted. i and di 3-door models are available in Softback and Hardback configurations. Softback vehicles of this specification feature a fabric roof assembly together with a removable flexible PVC rear window. Hardback vehicles vehicles of this specification feature a tail door drop glass.

XE derivatives are also available in either the Softback and Hardback configurations. On these derivatives, irrespective of the type of roof fitted, a rear tail door drop glass is fitted.

The fabric roof, which incorporates an integral tonneau cover, is secured to the rear roof section by two clamp fixings. It is attached to the “E” post by way of a bead integrated with the fabric which engages into a rear hood finisher moulding secured to the body.

The removable side screens also attach to the vehicle body by way of a bead incorporated into the side screen fabric panel which engages into a hood finisher moulding secured to the “D” post. A zip, situated along the upper and rear edges of the side screen panel, is used to attach it to the main roof section.

The main section of the roof is supported on a collapsible tubular steel frame. The frame pivots around a fulcrum point located half way up the “D” post. When folded forward, the integrated tonneau cover is passed over the folded assembly and clipped to the forward edge of the roof.

Figure 41

The flexible rear window, featured on the i and di Softback derivatives, is secured in position by way of a lower spar and a perimeter zip. The lower spar is secured to the vehicle by way of two removable pins, the rear clamps and the lower seal arrangement. The zip secures the rear window to the main fabric roof section.

If required, the fabric roof can be folded and removed from the vehicle as a complete assembly. This must be carried out in circumstances where a vehicle configured as a Softback is being converted to that of a Hardback, i.e. where a moulded roof is being fitted in place of a folding roof.

Figure 42

To remove the roof, the fabric must be released from the vehicle body, the two clamps securing it to the rear roof panel must be released and the steel frame must be released from it's fulcrum points. A special key, located in the vehicle glovebox, should be used to release the front clamp fixings. In addition, prior to the fitment of the moulded roof, the rear body clamps must also be removed. Again the special key should be used to release the clamp fixings.

Vehicles set in the Softback configuration and fitted with a rear tail door dropping glass, feature an additional sealing frame. The frame zips into the main roof section and secures to the rear clamps. The frame provides a rigid aperture into which the glass locates and seals.

It should be noted that the tail door drop glass can be raised and lowered as desired when the roof (folding roof or moulded roof) is in the up position. However, when the roof is folded forward or removed the state of a micro-switch located on the right hand “D” post, adjacent to the frame’s pivot point, is changed and the glass is automatically driven to its fully open, i.e. down, position.

1. micro-switch

Figure 43

This measure, which is a CCU controlled function, is designed to prevent the vehicle being driven whilst the roof is folded forward or removed and the glass in the closed or partially open, i.e. not in the fully down position. It should also be noted that the micro-switch will be activated by installation and removal of the moulded composite roof. This ensures a vehicle set in the Hardback configuration is not driven with the roof removed and the drop glass in the closed or partially open position. For a full description of the rear tail door dropping glass functionality, see the section on CCU.

The moulded roof assembly secures to the vehicle body by way of the four clamps. Although unique to the moulded roof assembly, the clamps share the same location on the vehicle as the clamps used to secure the folded roof assembly. Two clamps are located on the rear roof and two clamps are located on the body adjacent to the rear tail door aperture.

Care must be taken whenever fitting or removing either roof assembly from the vehicle. A supplementary fitting guide detailing the complete fitting and removal processes will be issued in the Owners Handbook information pack on all 3-door derivatives. This should be referred to whenever either procedure is undertaken.

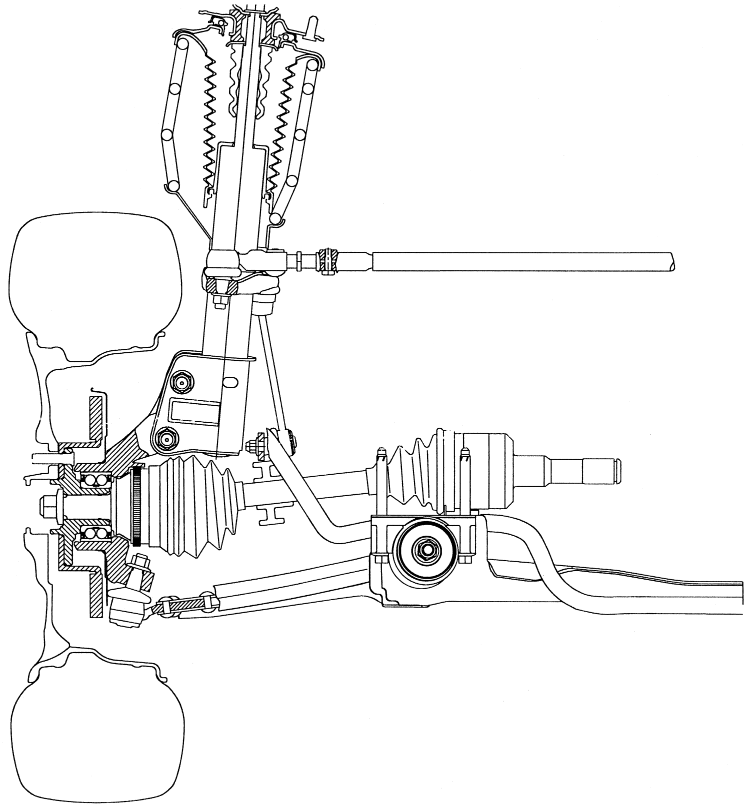
Steering and suspension introduction

The steering and suspension systems on all Freelander derivatives have been designed to deliver car-like levels of on-road performance, whilst achieving the off-road performance and durability required from the vehicle. Both the front and rear features independent suspension by McPherson struts This incorporates considerable levels of compliance and which contributes to both the on road refinement and off-road comfort. Careful design and extensive computer modelling was used to ensure that accurate geometry control is maintained throughout the range of suspension movement.

Off road performance has benefited from Land Rover's considerable experience in this field. Suspension members are mounted high on the vehicle to reduce the possibility of grounding. Extensive use of high strength materials and detailed analysis have been used to achieve the required off-road performance, whilst minimising weight.

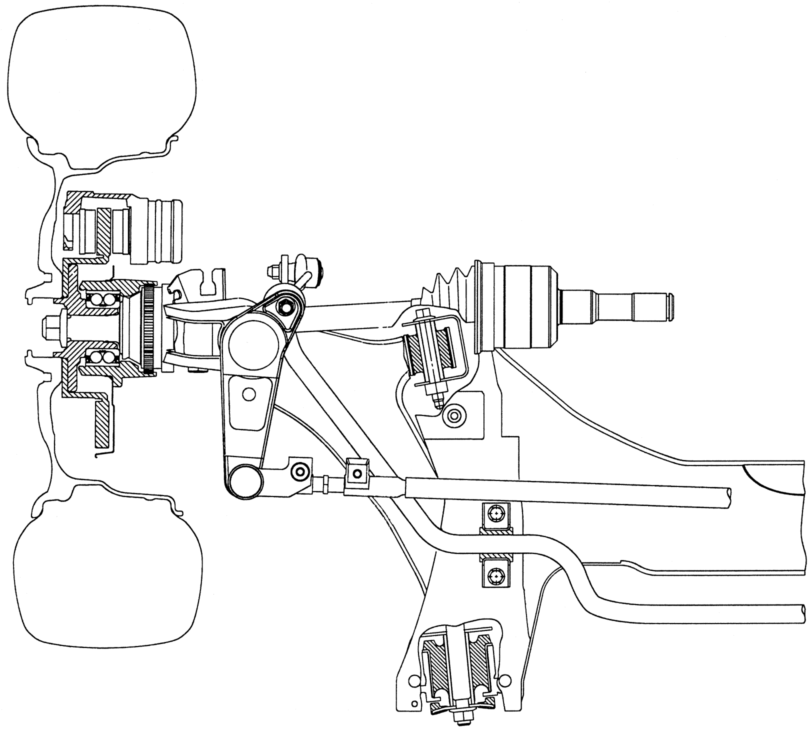
Front Suspension

The front suspension utilises a pressed steel lower control arm which is attached to a steel subframe. An anti roll bar is also secured to the subframe and is in turn secured via a link to the McPherson strut assembly.



Front suspension viewed from front

Figure 44



Front suspension plan view

Figure 45

Handling

A key factor governing the handling precision of the vehicle is the level of steer (or toe change) permitted by the suspension during its operation. Some steer effects are desirable, and are deliberately engineered into the suspension, whereas other steer effects are undesirable. Apart from the obvious steering wheel input, there are four primary sources of steer. These are as follows:

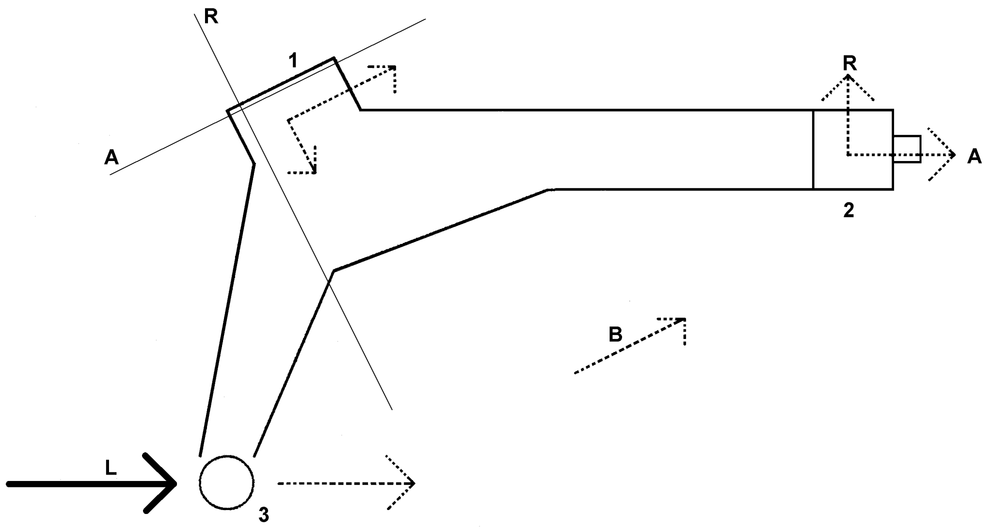
- Bump Steer
- Longitudinal compliance steer
- Lateral compliance steer
- Steering system compliance

Bump Steer

Bump steer relates to the toe change as the suspension is compressed and extended. As described earlier in this section, a “centre take off” steering rack is utilised on all derivatives of Freelander vehicles. This arrangement allows the use of very long track rods, which are high mounted on the suspension struts. The length of the track rods, and their mounting position on the strut, have been carefully chosen to limit bump steer changes over the full range of the suspension travel. The anti-roll bar is mounted to the struts by double ball jointed links. The links are carefully arranged to substantially reduce the unwanted steer effects usually suffered with this type of mounting.

Longitudinal Compliance Steer

Longitudinal compliance steer describes the toe change as the suspension complies forwards and rearwards, either due to bumps, braking or accelerating. The suspension has been designed specifically to maximise longitudinal compliance since greater compliance allows better ride comfort. This level of compliance is only possible if the suspension also limits toe change during compliance. The orientation of the suspension bushes have been carefully arranged to achieve this goal.



Mechanism of Longitudinal Force Steer (plan view)

1. Front Bush.	L. Applied Longitudinal Force.
2. Rear Bush.	B. Deflections..
3. Ball Joint.	A. Axial Complience.
	R. Radial Complience.

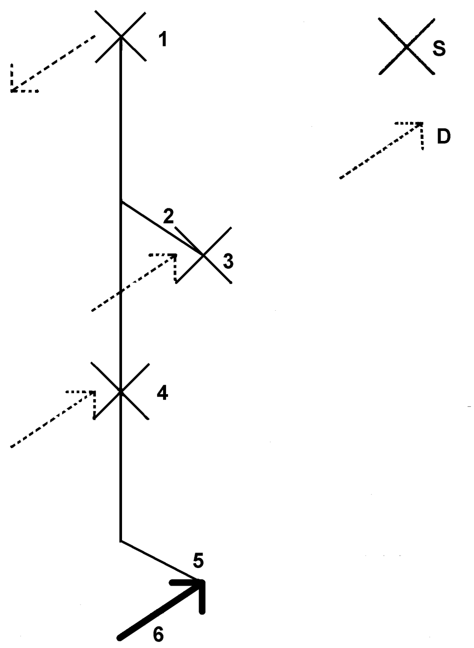
Figure 46

The bushes that support the rear of the lower suspension arm are located in a cast alloy housing. The bushes are mounted on the axis of rotation of the arm, and are relatively soft in the radial direction. In the axial direction the bush is very soft over the first 2mm of travel, but snubbing areas to the front and rear of the bush cause a progressive increase in the rate as the deflection increases. The rear bush primarily controls the extent to which the wheel may move forwards and backwards. The combination of these features allow considerable rearward wheel movement.

The front bush is mounted at a carefully specified angle to the axis of rotation of the arm. As the wheel moves rearwards the front bush is deflected both radially and axially, and the angle of the bush is so specified that the lower ball joint is constrained to move directly backwards. This feature reduces longitudinal compliance steer to very low levels.

Lateral Compliance Steer

Lateral compliance steer describes the toe change as the suspension complies in the lateral direction whilst cornering. The level of lateral compliance is governed by the stiffness of the lower arm front bush, the strut top rubber bushing, and the steering system compliance. Stiffness in these areas have been optimised to permit a small and controlled level of compliance steer in the toe-out direction.



Mechanism of Lateral Force Steer isometric view

1. Strut top mount (radial stiffness).
2. Steering Arm length.
3. Steering Complience.
4. Lower Arm front bush (radial stiffness).
5. Trail + Pneumatic Trail.
6. Applied Lateral Force.
S. Source of Complience.
D. Direction of complience in response to applied lateral force.

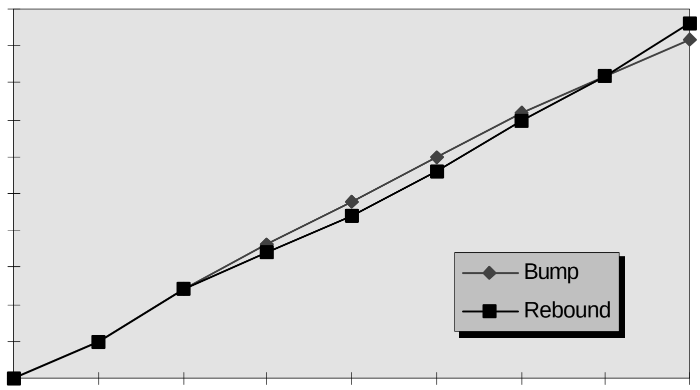
Figure 47

Steering System Compliance

Excessive levels would lead to vague steering feel. The steering system compliance has been minimised by specifying very stiff steering rack assembly mountings, track rod bushes, and suspension strut top mounting rubber bushes. The suspension strut also utilises a very strong forged steering arm, and thick wall large diameter outer tubing to allow positive transmission of steering forces.

Ride Characteristics

The front suspension utilises long travel coil springs, with the ride being substantially improved by allowing a carefully controlled amount of longitudinal compliance. This allows the wheel to move both rearwards and upwards in response to a bump. The provision of rearwards movement allow the springs and dampers more time to absorb the bump, and hence eliminates the harshness associated with less compliant suspensions. The dampers adopt the characteristics that have provided the latest Range Rover models with their exceptional levels of ride comfort. The dampers possess two novel characteristics these being similar bump and rebound damping, and a fundamentally linear characteristic. See figure below.

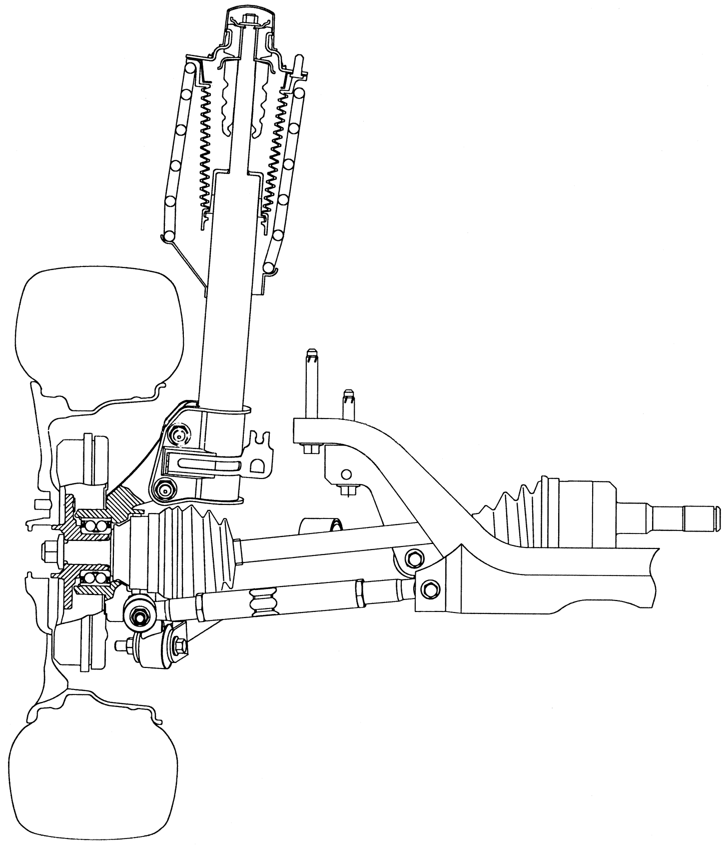


Damper Rate Chart

Figure 48

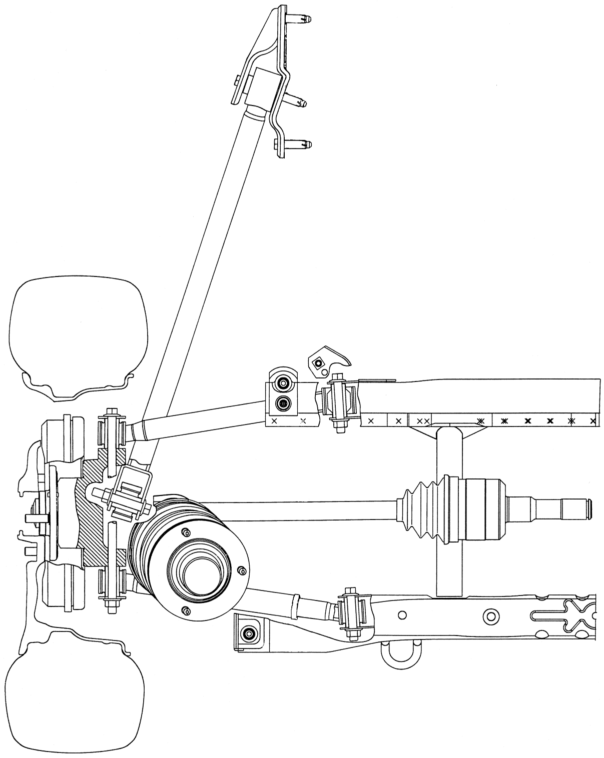
Rear Suspension

The rear suspension features McPherson struts with coil springs and lower “trapezoidal links”. The links are mounted to a substantial steel subframe via cylindrical bushes. The trapezoidal link arrangement consists of two transverse links, controlling lateral location and steer location, with a trailing link controlling longitudinal location. The positioning of the links and the stiffness of the bushes are a key influencing factor on the performance of the suspension.



Rear suspension viewed from rear

Figure 49



Rear suspension (plan view)

Figure 50

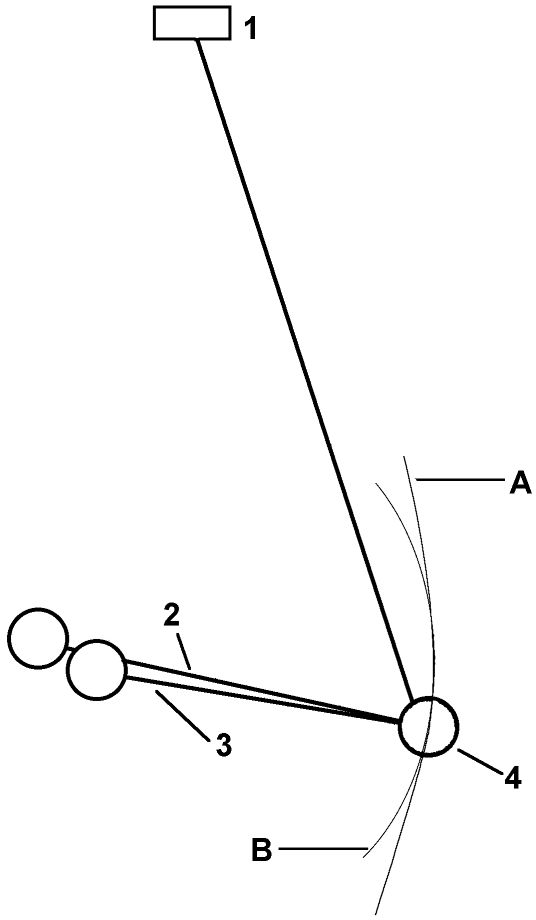
Handling

As with the front suspension a key factor governing the handling precision of the vehicle is the level of steer that the suspension allows during operation. The key to achieving safe and predictable handling on a rear suspension is to induce small levels of toe in response to load inputs (bumps, braking, accelerating etc). In respect of the rear suspension there are three primary sources of steer effects:

- Bump steer
- Longitudinal compliance steer
- Lateral compliance steer

Bump Steer

By utilising two transverse links of similar lengths, bump steer is reduced to very small levels. The front link is slightly shorter than the rear link, which promotes a small amount of stabilising toe-in during cornering.



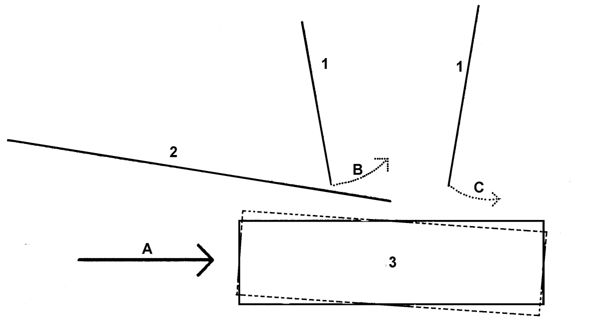
Mechanism of bump steer

1. Strut top mount
2. Rear link (longer)
3. Front link (shorter)
4. Transverse link outer bushes
A. Path of rear transverse link (larger radius.
B. Path of lower front link path is the key to toe-in into bump).

Figure 51

Longitudinal Compliance Steer

The transverse links on the rear suspension are arranged at an angle to each other. As the suspension moves rearward the front link has a tendency to move slightly inward, and the rear link has a tendency to move slightly outward. This creates the required toe in characteristic.



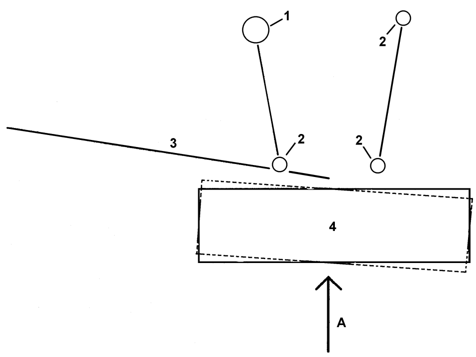
Mechanism of Longitudinal Force Steer (plan view)

1. Transverse Links	A. Applied Longitudinal Force
2. Trailng Link	B. Path of Front Link
3. Wheel & Tyre	C. Path of Rear Link

Figure 52

Lateral Compliance Steer

The lateral steer performance of the rear suspension is governed by the ratio of the stiffness of the transverse link bushes. Three of the four bushes in the links are very stiff, this provides handling precision and reduces transient steer effects. The fourth bush is the front transverse link to the subframe, this bush is tuned to have a very soft initial rate and a progressively increasing rate as the deflection increases. This characteristic allows the small levels of stabilising toe-in.



Mechanism of Lateral Force Steer (plan view)

Figure 53

1. Soft Bush.	4. Wheel & Tyre.
2. Stiff Bushes.	A. Applied Lateral Force.
3. Trailing Link.

Ride

The ride is substantially improved by allowing considerable longitudinal compliance. This allows the wheel to move both rearwards and upwards in response to a bump. The provision of rearwards movement allows the springs and dampers more time to absorb the bump, hence eliminating the harshness associated with less compliant suspensions. The rear dampers employed on the rear have the same linear damping characteristics as the front dampers.

Coil Springs

A variety of coil springs are available to suit the various derivatives within the Freelander range. As various springs exist for Freelander vehicles, the importance of fitting the correct spring for the specific vehicle application is extremely important. In circumstances where the wrong spring has been fitted, damage may be caused to the vehicle driveline, or the vehicles handling characteristics may be severely impaired. The table below describes the various spring combinations.

Model	Front	Rear
Petrol	Blue	Pink
Petrol (with air conditioning)	White	Pink
Diesel	Brown	Pink
Diesel (with air conditioning)	Yellow	Pink

Trim Heights

The trim height should be checked by measuring the vertical distance from the centre of the wheel hub, to the lower edge of the wheel arch. The conditions for checking the trim heights are:

- Vehicle unladen
- No driver or passengers in the vehicle
- Vehicle should be checked with a full tank of fuel

Model	Front	Rear
Petrol	453mm ± 10mm	470mm ± 10mm
Diesel	453mm ± 10mm	470mm ± 10mm

Off Road Performance

Approach Angle	Departure Angle	Breakover Angle	Ground Clearance
30°	34º	24°	190mm

Steering

Since the introduction of the first Series One Land Rover in 1948, this and all subsequent production vehicles have featured a steering box to transmit the driver inputs to the front wheels. The Land Rover Freelander will be the first production Land Rover to feature a rack and pinion steering arrangement.

The steering rack is mounted to the body via two cylindrical bushes, its position was carefully chosen to reduce the risk of the steering column intruding into the passenger compartment in the event of an accident. The overall ratio of the steering rack is 19.6:1 and has 3.16 turns lock to lock. This relatively high ratio provides good steering response.

The track rods are connected to the centre of the steering rack, this “centre take off” type steering rack dictates that the track rods are longer than on a conventional type of steering rack. This arrangement allows for extremely low levels of “bump steer”, and also permits long suspension travel.

All derivatives of Freelander are equipped with power assisted steering as a standard feature. Assistance is provided by means of an engine driven hydraulic pump, and a hydraulically assisted steering rack. Also included in the system is an oil cooler to reduce the temperature of the hydraulic fluid, and an orifice valve. The valve reduces harsh feedback from the road wheels.

Shock Absorbing Steering Column

The steering column incorporates an energy absorption mechanism designed to reduce occupant impact loads in the event of an accident. The column is mounted at four points consisting of upper and lower points. The upper two mounting points are designed to progressively deform when an axial load is applied to the column, whilst the lower two mounting points remain fixed. When the upper mounting point bracket deforms the column becomes shorter. In the event of rearward displacement of the steering gear movement is accommodated by the angles of the universal joints.

Adjustable Steering Column

The steering column is provided with a mechanism that permits 3.5 degrees of adjustment, this is equivalent to 30mm of vertical steering wheel movement. The adjustment lever acts on a special bolt that clamps the column in position when the lever is raised, and when lowered, releases the column to slide within a slot.

Security

The column and lock contain a number of features to retain the integrity of the steering column lock. The column contains a slipping mechanism, designed to prevent the column lock from being deliberately broken. The column lock itself is resistant to forced turning and forced removal.

Tyres

Unlike many of Freelanders' competitors, the off-road performance of the vehicle was not compromised by specifying ordinary road tyres. The tyres fitted to Freelander have been specifically optimised to provide exceptional levels of mud, snow and sand traction, with superior off-road durability. Together with the off-road capabilities, the tyres also maintain a high level of on-road refinement and performance.

Supplementaty Restraint System (SRS)

Introduction

In recent years, technical advancements in occupant safety have significantly reduced the risk of injury to occupants in road accidents. Land Rover’s commitment to further enhance vehicle safety has led to an increase in the level of protection offered by the vehicle restraint systems fitted to its products.

Features designed to complement the 3 point diagonal seat belt provided for front occupants, are known as Supplementary Restraint Systems (SRS). In most instances the term SRS refers to the use of components such as airbags to restrain the front seat occupants.

During frontal impacts, the occupants move forwards under the deceleration forces until the seat belt retractor locks up. The amount of forward travel may vary depending upon the webbing “payout” prior to impact, i.e. wearing thick winter clothing. The fitment of frontal airbags complements the seat belt restraint system by providing further occupant protection.

All derivatives of the Land Rover Freelander feature a driver airbag as standard. A passenger airbag is a standard feature on certain vehicles, and can be specified as an option on others.

For the first time Land Rover are introducing front seat belt buckle pretensioners on all derivatives of Freelander vehicles to complement the restraint system. Pretensioners are fitted to all Freelander derivatives. On impact the seat belt buckle pretensioners reduce the amount of slack in the seat belt. This is achieved by retracting the seat belt buckle in the event of a severe frontal impact.

Safety Precautions

Before commencing work on the SRS or any of its associated components, it is vital that certain safety precautions are adhered to. The first two items in the following list must be performed in sequence.

1. Switch off the ignition and remove the ignition key from the switch.
2. Disconnect the battery terminals. The negative terminal should be disconnected first, followed by the positive terminal. Wait 10 minutes before proceeding. This allows the reserve energy capacitors incorporated in the system to fully discharge, thereby preventing the possibility of accidental airbag, or pretensioner deployment.
3. Never substitute components from another vehicle.
4. Never cut, splice or make any attempt to repair any wiring or associated SRS components.
5. Never dismantle or incinerate any of the airbag components, or pyrotechnic seat belt buckle pretensioners.
6. When an airbag module is removed from the vehicle, it must be temporarily stored in the boot of the vehicle with the trim facing upward, (always ensure the boot is secured).
7. When carrying an airbag module always ensure that the metal base is facing away from your body i.e. the cover towards you. Never wrap your arms around the module.
8. Always ensure that airbag components are kept in a cool and dry environment.
9. Always disconnect the battery before carrying out any electric welding on the vehicle.
10. Never “probe” into any electrical connectors associated with the SRS with multimeters or any other general purpose test equipment.
11. A fault with the SRS should only be diagnosed using TestBook and the appropriate CD.
12. Always ensure that the DCU is secured correctly in accordance with the Repair Manual instructions, and that fixings are secured to the correct torque.
13. Always use new fixings on replacement of any SRS component.
14. If an airbag module has been deployed, be aware that it will be hot for up to 30 minutes.

Important: Improper handling or storage can result in internal damage to the SRS components rendering them inoperative. In circumstances where you suspect a component has been dropped or damaged, always install a new unit.

System functionality

The SRS on Freelander derivatives is controlled by an electronic control unit known as an AC4 version Diagnostic Control Unit (DCU). The DCU has the following functions:

1. The unit must continually monitor for possible crash conditions severe enough to warrant airbag deployment. In such circumstances, the DCU will deploy the airbags and the seat belt pretensioners simultaneously.
2. The unit also features full self diagnostic capabilities to ensure correct performance and functionality. The diagnostic capabilities require constant assessment, as opposed to the “one-off” deployment function, therefore the control unit will always be referred to as a Diagnostic Control Unit (DCU).

In common with the Diagnostic Control Units fitted to post 97 MY Discovery and Range Rover vehicles, the DCU on Freelander models is of the Single Point Sensing (SPS) variety. This means that the crash sensing, and the mechanical safing sensor are both housed within the DCU.

In the event of a severe frontal collision, the crash sensor measures the deceleration of the vehicle through the use of a accelerometer. This is an electronic device which has the capability of processing deceleration data. In circumstances where the accelerometer measures deceleration forces of a predicted value and characteristic, deployment will be initiated the through the DCU electronics.

The mechanical safing sensor is a device that is monitored by the DCU electronics. In conjunction with the information provided by the crash sensor regarding deceleration, the safing sensor must also be in a closed position, thus completing the electrical circuit. When all these conditions are met, deployment of the airbags and seat belt pretensioners will occur.

Also contained within the DCU are four energy reserve capacitors. These are installed to ensure an adequate supply of electrical energy is always available to deploy the airbags and seat belt pretensioners. The capacitors are able to store the electrical energy required to complete ignition of the detonators contained in the airbags and seat belt pretensioners, and have the capability of storing this electrical energy for 150ms after the loss of battery voltage supply. This feature enables the deployment of all the necessary detonators, even if the battery supply is lost during impact.

The DCU contains an additional capacitor which is capable of providing electrical energy for 200ms after loss of battery voltage. This enables the DCU to store data on the crash event, before and after the airbags have been deployed. With the inclusion of this feature, by using the appropriate equipment the DCU memory can be read after the event of an accident. This provides a means of analysing the functionality of the various parameters within the SRS before, during and after a crash event

The illustration below shows the installed location of the DCU and the ground connection.

Figure 54

Crash Lock Mode

When a crash deployment decision has been taken and crash recording completed by the DCU, the DCU will permanently illuminate the SRS warning whenever the ignition is switched to position 2. At this stage the DCU enters a mode referred to as "Crash Locked Mode". Once the DCU has entered the "Crash Locked Mode" no further deployment of the SRS components is possible, thus rendering the DCU inoperable.

SRS warning lamp functionality

- As part of the SRS start-up procedure the lamp will illuminate when the ignition is switched on. The lamp will illuminate for approximately 5 seconds. If no faults in the system are detected the lamp will then extinguish. If a fault is detected during the SRS start-up procedure, the warning lamp will be illuminated for approximately 5 seconds, and then should briefly extinguish. The lamp will then re-illuminate, and will stay illuminated for the entire ignition-on cycle. In circumstances where the warning lamp fails to illuminate during the start-up procedure, the existence of a fault should be assumed in either the lamp or power supply to the DCU.

- If the warning lamp illuminates when the ignition is switched on, and remains illuminated without briefly extinguishing, the existence of a system fault should be assumed. In this scenario, the cause of the fault is likely to be the connection to the DCU, the ground or the associated SRS wiring.

- If the DCU detects that a fault has occurred whilst the ignition is on, the warning lamp will be illuminated for the entire ignition-on cycle. If the fault is no longer present during the next ignition on cycle the warning lamp will be extinguished. However a fault code will be logged in the DCU memory. If the fault code is still present during the next ignition on cycle, the warning lamp will illuminate when the ignition is switched on and remain illuminated.

To enable accurate measurement of the inputs to the DCU, the supply voltage must be maintained within defined parameters. These voltage parameters are as follows:

Limit	Voltage
Voltage low	9.4 ± 0.8V
Voltage high	16.2 ± 0.9V

- If the voltage supply exceeds these parameters the warning lamp will be illuminated for the duration of the error, and a fault will be logged into the DCU memory.

- During periods where the DCU has identified a voltage value outside the given parameters, all diagnostics will be suspended. This measure is invoked as the accuracy of the diagnostic measurements cannot be guaranteed when the voltage supply is outside the defined levels. However in the event of an impact, the DCU will still attempt to deploy the airbag and seatbelt buckle pretensioners untill the voltage drops to below approximately 6.5 volts.

Rotary coupler

The rotary coupler is employed to provide a reliable electrical connection to the driver's airbag module and associated steering wheel controls, e.g. horn etc. Contained within the rotary coupler is a rotating wiring harness which allows 6 turns from end to end. The rotation, and position of the wiring harness is monitored by a centre position indicator located on the cassette which should be used during service procedures.

Always refer to the Repair Manual before removal of the rotary coupler, and follow the safety precautions outlined earlier in this section. In addition, ensure that the steering wheels are in the straight ahead position. After removal of the steering wheel and cowl, check the position indicator and ensure that the "white face" is uppermost. The casing of the rotary coupler can be temporarily locked with tape to ensure the wheel does not move from the centre position.

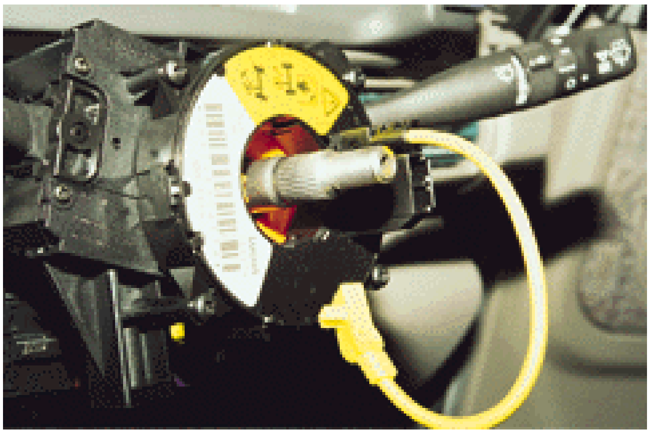


Figure 55

When installing a previously used rotary coupler, ensure that it is positioned centrally prior to installation. This position is indicated when the white segment is in its uppermost position with the steering wheels in the straight ahead position. On initial fitment of a new rotary coupler the factory centred position is indicated by the fitment of a blue locking peg installed in the cassette assembly. The peg should remain installed until the moment the steering wheel is about to be installed. In circumstances where the centred position has been lost, the following procedure can be used to reset the coupler before installation.

Hold the main body of the coupler, and gently turn the inner case of the cassette in an anti-clockwise direction until a moderate amount of resistance is felt. Then turn the inner body of the cassette in a clockwise direction, (approximately 6 turns should be achieved) before a moderate amount of resistance is felt. Turning the inner body of the coupler a further 3 turns in an anticlockwise direction should set the coupler in the centred position. The correct position of the cassette can be confirmed by observing the position of the white position indicator wheel. If the white indicator is not in the uppermost position at this point, discard the coupler. This is necessary as the internal wiring harness may be damaged.

Diagnostic

The SRS system is operational from the moment the ignition is turned to position 2. When the system is initially powered up, the warning lamp situated in the instrument panel should illuminate as described previously. This serves as a warning lamp functionality check, in normal circumstances the lamp should extinguish after approximately 5 seconds. In the event of an SRS system fault been detected, (internal or external to the DCU), the warning lamp will remain illuminated. Or, if a fault is detected after the lamp has extinguished, the lamp will be illuminated in both cases, and a fault code will be stored in the DCU memory. Fault codes can be accessed using TestBook via the 16 pin diagnostic connector situated on a bracket above the transmission tunnel, and behind the centre console.

In the event of a total loss of power to the SRS DCU or failure of the warning lamp bulb, the warning lamp in the instrument panel will not illuminate during the preliminary ignition on lamp check, such faults should be investigated immediately. The electrical circuits used to transmit electrical signals within the SRS system are continuously monitored by the DCU.

The number of deployment circuits for the various gas generators (e.g. airbag and pyrotechnic seat belt pretensioners), monitored by the DCU will be determined by the information stored in its memory. During production Freelander SRS DCU's are configured to suit the vehicles specification i.e. to be compatible for driver only, or driver and passenger applications, always with seat belt pretensioners.

A diagnostic test is carried by the DCU to determine the condition of the component, and wiring integrity on each of the output circuits. The circuit resistance is measured by passing a very small current (approximately 40 mA) through the relevant circuit.

The following table outlines the resistance parameters for each component in the circuit.

Note: As already stated in the safety precautions, no attempt should be made to check any SRS component with a multimeter or any other general purpose test equipment. The values below are purely for reference purposes only.

Fault	**Driver airbag circuit**	**Passenger airbag circuit**	**Seat belt pretensioner circuit**
High resistance	5.5 ± 0.5Ω	5.5 ± 0.5Ω	5.5 ± 0.5Ω
Low resistance	1.5 ± 0.5Ω	1.5 ± 0.5Ω	1.5 ± 0.5Ω

NB: These resistances must **not** be measured.

During the start up sequence the DCU measures the resistance across each of the output lines. This check determines whether the relevant gas generators are adequately connected to the SRS wiring harness. In conditions where poor connections exist between the wiring harness and a component, a high circuit resistance would result. By comparison, short circuits between the supply and ground connection would result in a low circuit resistance. both faults would be detected by the DCU which would store details of the fault and illuminate the warning lamp as previously described.

Wiring harness

Land Rover vehicles, such as Discovery and Range Rover, have previously employed a separate SRS wiring harness independent of the vehicles main interior wiring harness. In this application, the SRS wiring harness could be easily identified by a yellow plastic shroud that covered the complete SRS wiring harness.

A new feature for Freelander vehicles is the integration of the SRS wiring harness and the vehicles main interior wiring harness. As a result of this inclusion part of the SRS harness is no longer covered with the yellow plastic shroud. However the SRS harness integrated in the main interior harness, can be identified by yellow tape wrapped around the SRS wiring at regular intervals.

It should be noted however, that the wiring leading from the main interior harness to SRS components, can still be identified by a short yellow plastic shroud.

In circumstances where the deployment of the airbags and seat belt pretensioners has taken place, all SRS components should be replaced. This should include the replacement of the SRS wiring harness, i.e. the main interior harness.

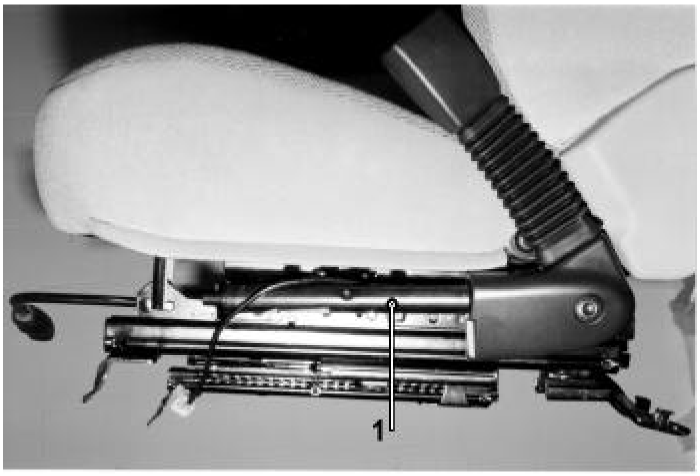
Seat belt pretensioners

As referred to earlier in this document, all derivatives of the Land Rover Freelander are equipped with pyrotechnic seat belt buckle pretensioners. They are secured directly to the seat frames, and are fitted to both front seats.

In modern motor vehicle applications, essentially two types of seat belt buckle pretensioner are available. These are the mechanical type, and the pyrotechnic type. Most mechanical pretensioners operate independently from the control of the DCU. Often these components have their own inertia sensing device incorporated into the unit. In the Freelander application, pyrotechnic seat belt buckle pretensioners are used. In this application the seat belt buckle pretensioners are controlled by the DCU. In circumstances where the DCU has taken a deployment decision, seat belt buckle pretensioners and frontal airbags will be deployed simultaneously.

Location of Pretensioner

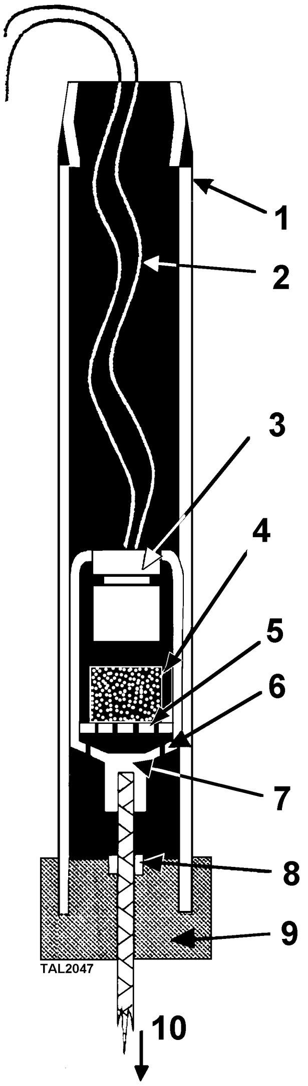
The pretensioner is located along the side of the front seats and is orientated in a horizontal position as can be seen below.



1. Pretensioner

Figure 56

A pyrotechnic device is located in a piston, which is retained in a cylinder. A cable is attached to the piston and seat belt buckle. Activation occurs when the relevant electrical signals are transmitted to the pretensioner by the DCU, and the chemical propellant starts to burn. As the chemical propellant burns, a large quantity of high pressure gas is created in the cylinder. This forces the piston and cable along the cylinder, which in turn retracts the seat belt buckle assembly thus reducing the slack in the belt.

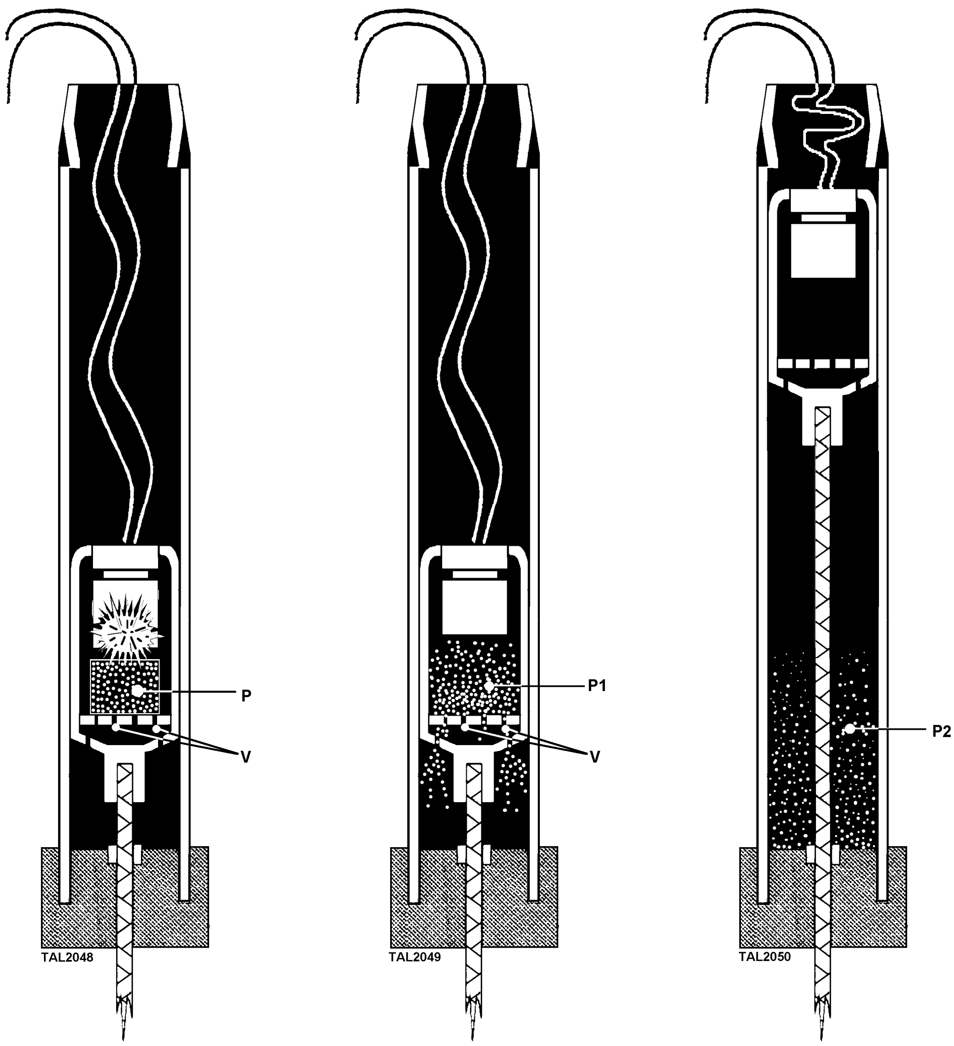


1. Outer Tube.
2. Firing Circuit Wire.
3. Initiator.
4. Propellant.
5. Retainer Plate.
6. Gas Choke.
7. Piston Assembly & Housing.
8. Seal.
9. Seal Housing.
10. Cable

Pretensioner cross section

Figure 57

Pretensioner retraction events.



V. Vent Holes in Retainer Plate.
P. Propellant.
P1. Initiator ignites propellant which escapes through vent holes. Pushing piston assembly in the opposite direction inside pretensioner tube.
P2. Spent propellant escapes through vent holes and gas choke.

Figure 58

Driver airbag

As stated previously, all Freelander derivatives are supplied with a driver airbag as standard equipment. The airbag module is secured to the steering wheel by means of two 6mm Torx head screws. The screws should be replaced whenever the airbag module is removed.

Contained within the airbag module assembly is an airbag, which when inflated has a capacity of approximately 45 litres. Also contained within the module assembly is a gas generator and nitro-cellulose chemical propellant. When the relevant electrical signals are transmitted from the DCU to the igniter in the gas generator, combustion occurs and the rapidly expanding gas causes the airbag to inflate. As the pressure rises, the airbag expands and appears through designed tear lines in the module cover. The airbag deflates after maximum pressure occurs, causing no obstruction to driver visibility.

Passenger airbag

A passenger airbag is supplied as standard equipment on xe, and can be specified as an option on I and di derivatives. The airbag module is secured to the facia by means of four fixings. Two fixings secure the airbag module to a bracket, which in turn is secured to the body by the other two fixings. The bracket is excluded from vehicles not equipped with a passenger airbag.

Contained within the airbag module assembly is an airbag, which when inflated has a capacity of approximately 120 litres. Also contained within the module assembly is a gas generator and sodium azide chemical propellant. When the relevant electrical signals are transmitted from the DCU to the igniter in the gas generator, combustion occurs and the rapidly expanding gas causes the airbag to inflate. As the pressure rises, the airbag expands and appears through a designed tear seam in the module cover.

Important: When working with SRS components, always refer to the Repair Manual for information regarding fixing torque.

Service life

After a period of ten years from the date of registration (or the date of installation of a replacement airbag SRS component), some components in the SRS will need to be replaced. **(See the airbag modules replacement date shown in the service record book).**

To ensure absolute safety, this work must only be carried out by an authorised Land Rover dealer, who should stamp and sign the appropriate page in the service record book.

Braking System

All derivatives in the Freelander range feature a diagonally split brake circuit configuration. A vacuum servo is incorporated into the system to provide assistance via a tandem brake master cylinder. A Pressure Conscious Reduction Valve (PCRV) is included in the circuit. The valve ensures that the desired proportion of fluid pressure is distributed to the front and rear brakes during brake application.

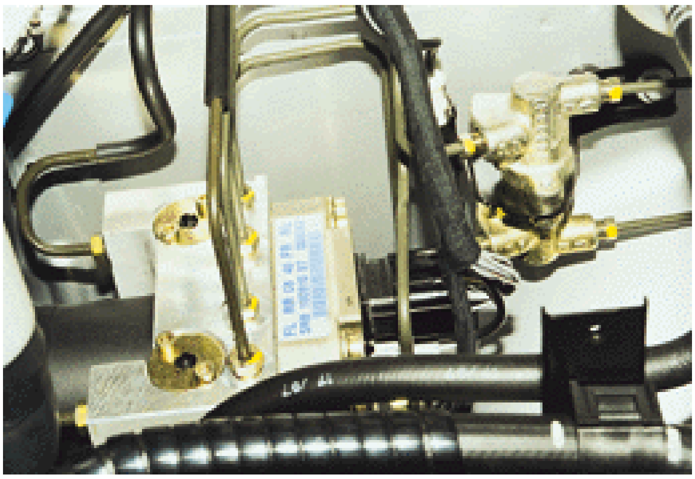
The front brakes consist of two solid 262mm diameter discs, with single piston sliding calipers. Two, 254mm diameter, drum brakes are employed on the rear. The rear drum brake also incorporates the hand brake mechanism, a feature traditionally incorporated into the rear propeller shaft of the transfer gearbox on other Land Rover products.

Antilock Braking System (ABS)

An Antilock Braking System (ABS) is available as a standard feature on Freelander XE derivatives, and is offered as an option on Freelander i, and di derivatives. This is a completely new Wabco system designed specifically for the Freelander application. It is a four channel system providing independent braking control over all four wheels.

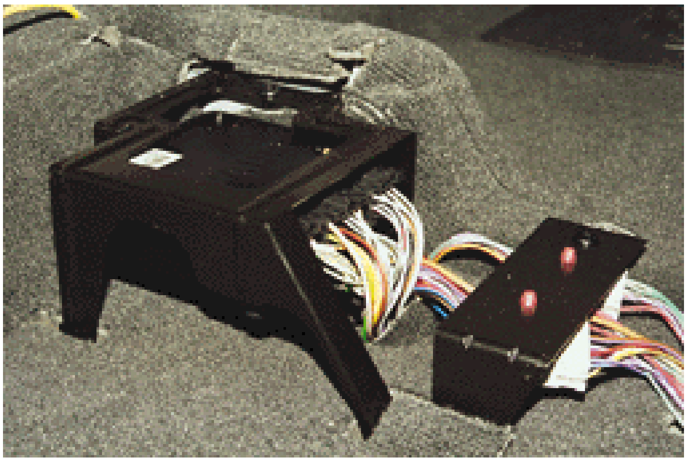
The Wabco system incorporates a combined modulator and return pump assembly located on the right hand front inner wing panel. An Electronic Control Unit (ECU), located under the RH seat controls the system. ECU's fitted to other Land Rover vehicles equipped with Wabco ABS systems are referred to as "C" Series ECU's. For the Freelander application a new generation of ECU, referred to as the "D" Series ECU has been introduced. This new ECU features an improved microprossessing capability and is responsible for controlling additional functionality within the system.

ABS Modulator and PCRV



Modulator

Figure 59



ABS ECU Location

Figure 60

Information regarding vehicle road speed is transmitted to the ABS ECU via four inductive pulse sensors. The sensors are of the push fit type and are housed within the hubs of all four wheels. Reluctor rings, machined with sixty poles are situated on each driveshaft. Each reluctor ring turns in close proximity to the sensors. The turning motion of the reluctor ring causes the sensors to generate an output voltage signal. The signal generated is directly proportional to the periodic variation in the poles machined into the reluctor. As the reluctor rings are machined with a uniform pole pattern i.e. the distance between all poles is the same. A sinusoidal voltage curve is generated when the wheels rotate. The signal is then transmitted to the ECU for internal processing.

Vehicle Speed

Vehicles without ABS transmit information on vehicle speed to the speedometer from a hall effect speed transducer. The speed transducer is directly driven from a mechanical drive located in the top of the gearbox.

Vehicles equipped with ABS transmit information on vehicle speed directly from the ABS ECU. The ECU supplies the signal to the speedometer in the form of a Pulse Width Modulation (PWM) signal. The signal is based on a calculation using the signals received from all four wheel speed sensors. In the event of one or more sensors failing, the ECU is still capable of supplying a speed signal based on the information from the remaining sensor. In this event the driver will be informed of the existence of such faults via the ABS warning lamp.

Hydraulic Circuit Operation

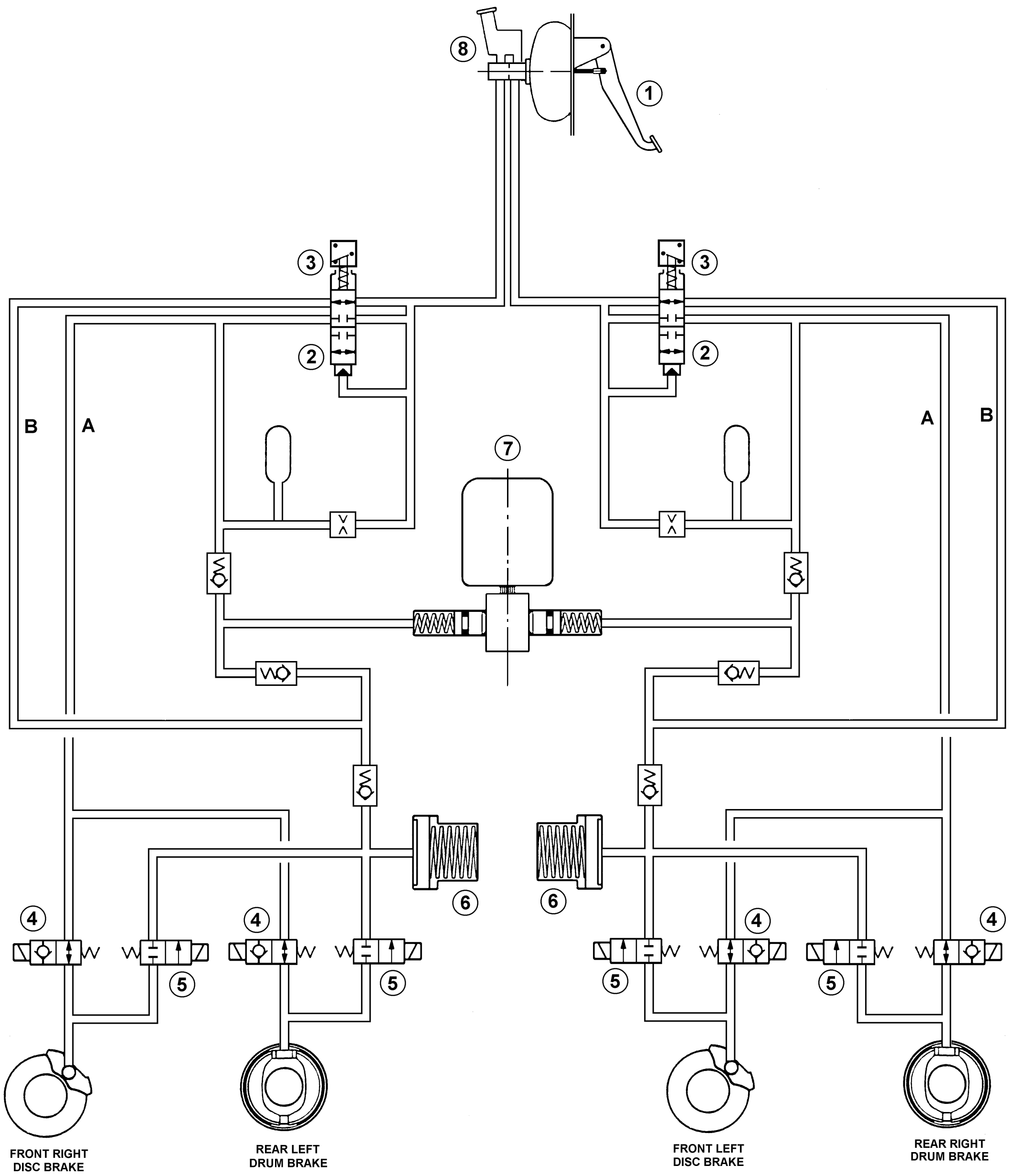
When the brake pedal (1) is pressed, the shuttle valve (2) is moved by hydraulic pressure and opens line A. As the shuttle valve moves it also triggers the shuttle valve switch (3). This informs the ECU that the brake pedal has been pressed. Pressure will be fed down line A to the front and rear brakes.

A conventional type brake pedal switch is used to switch on the brake lamps when the brake pedal is pressed. The switch is not used to supply any information to the ABS ECU.

During “normal” non-ABS braking events the inlet valves (4) are in the open position, and the outlet valves (5) are in the closed position. This allows hydraulic pressure to act on the front calipers and rear brake cylinders and applies the brakes.

If the ECU detects via any of the wheel speed sensors, that a wheel is close to the point of locking, the system will instigate the ABS function. The inlet valve (4) of the that wheel will be closed and the outlet valve (5) will also remain in the closed position. At this point no increased pedal pressure is allowed to the caliper or drums. At the same time, pressure between the closed inlet and outlet valve is maintained at the caliper or drum. Therefore the pressure acting at the wheel will remain constant. The ECU will continue to monitor the wheel speed and calculate whether the wheel is still at the point of locking. If the ECU decides that the wheel is no longer in danger of locking, the inlet valve (4) will be opened thus allowing pedal pressure to increase at the caliper or drum. If the ECU decides that the wheel is still in danger of locking, the inlet valve will remain closed, and outlet valve will be opened.

This fills the expansion chambers (6) enabling pressure to be released from the brakes. At the same time the re-circulation pump (7) is activated and fluid is drawn into the pump circuit. Pressure is then re-circulated in and out of the brakes by controlled modulation of the inlet and outlet valves.



Schematic hydraulic circuit diagram

1. Brake Pedal.
2. Shuttle Valve.
3. Shuttle Valve Switch.
4. Inlet Solenoid Valve.
5. Outlet Solenoid Valve.
6. Expansion Chambers.
7. Recirculation Pump.
8. Master Cylinder.

Figure 61

Warning Lamp

The warning lamp is an amber lamp with the letters “ABS” in a circle. The lamp will illuminate when the ignition key is turned to position 2, and will remain illuminated until the vehicle has attained a speed over 7 km/h. This enables the system to verify that the wheel speed sensors are operating correctly. The lamp will also illuminate whenever a fault has been detected in any of the system components.

In line with current Land Rover practice, as used on Discovery and Range Rover vehicles, the warning lamp will briefly extinguish and re-illuminate during the ignition-on lamp check. This will only happen in circumstances where no faults are stored within the ABS ECU memory. If a fault is stored in the ECU memory, the lamp will stay illuminated during the ignition on check.

Electronic Traction Control (ETC)

An ETC feature is incorporated into the braking system whenever ABS is specified.

When accelerating on slippery surfaces, loss of traction can occur and one or more wheels may spin. This can result in a loss of control over the vehicles direction. It can also cause a loss in vehicle momentum, resulting in the vehicle becoming “bogged down” in muddy conditions. To minimise the risk of this occurring each wheel is prevented from spinning by the brake systems electronic traction control capability.

ETC is provided by brake intervention and can operate on all four wheels. It distributes the available engine torque to the wheels that most need it and therefore enhances the vehicles already impressive traction capabilities in difficult conditions. The ETC function is active up to 50km/h and is completely automatic in its operation.

ETC Operation (See Figure 57)

When the ECU detects wheel spin via the wheel speed sensors, ETC can be instigated on any of the four wheels. A pre-requisite for ETC operation is that the brake pedal is not pressed.

In circumstances were the brake pedal is pressed, ETC is inhibited by the ECU. In operation, the system starts by activating the return pump (7). The shuttle valve (2) is in its rest position and line B is open to the master cylinder (8). Fluid is drawn from the reservoir into the pump circuit and subsequently into the brakes. The inlet (4) and outlet (5) valves, in response to ECU inputs, control the pressure to the front and rear brakes.

Warning Lamp Operation

The system employs one amber lamp which has the letters “TC” in dotted circle. The lamp will illuminate during the ignition on lamp check. The system will indicate ETC operation by illuminating the amber TC lamp for a minimum of 2 seconds. The lamp will also illuminate when a fault is detected in any of the ETC components.

If a sensor fault had occurred and had been rectified in the previous driving cycle, the TC lamp will remain illuminated together with the ABS lamp until the vehicle has been driven over 15 km/h. This enables a more in-depth check to be performed by the ECU, to ensure the wheel speed sensors are functioning correctly. The ETC functionality will be disabled until the sensor outputs have been verified.

ABS Interface With Engine Control Module (ECM)

Information regarding engine status is transmitted from the ECM to the ABS ECU whenever the engine is running. The information is received via a multiplexed signal from the ECM to ABS ECU at pin number 10. In total four areas of information are transmitted:

- *Engine identification signal* - This provides the ABS ECU with details on engine type e.g. petrol or diesel.

- *Throttle position signal* - This is received by the ECM from the throttle position sensor. It enables the ABS ECU to determine exact throttle position.

- *Engine speed signal* - This is received by the ECM from the crankshaft position sensor. It enables the ABS ECU to determine the actual engine speed.

- *Engine torque signal* - The ECM calculates this signal using information received from a number of sensors within the engine management system. It enables the ABS ECU to make necessary changes to the operation of the HDC and ETC function when the engine torque output changes.

Hill Descent Control (HDC)

As already mentioned in this brochure, a traditional feature on all other Land Rover vehicles has been the inclusion of a transfer gearbox. This feature serves several purposes, including the provision of high and low gear ranges for effective off-road driving. The transfer gearbox can also be used to good effect when negotiating steep descents when in off road conditions. With the aid of a transfer gearbox, descending a steep hill with poor adhesion can be negotiated by selecting low range. Selection of low range results in a useful engine braking effect, which can be used to provide controlled descent, minimising the need for foot brake application. In such circumstances, application of the brakes should be avoided as wheel lock may occur, resulting in loss of directional control where ABS is not fitted.

The conventional transfer gearbox configuration is not featured on any Freelander derivatives. This presented an engineering challenge for an alternative arrangement with regard to controlling the vehicles traction during hill descents.

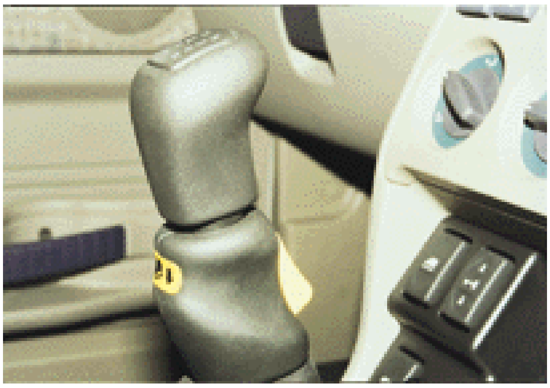
The solution to the problem is a unique feature developed specifically for Freelander. The feature is known as Hill Descent Control (HDC), and is an integral part of the ABS system. It provides well controlled descent ability without the need for a low range gear. The HDC system uses the traction control hardware contained within the ABS system, and it is designed to provide control during steep hill descents when overrun engine braking is insufficient to maintain a comfortable driving speed. To eliminate inappropriate operation of the HDC function, the system will only operate when first or reverse gears are selected.

A number of advanced features and interfaces within the system enable the driver to switch the system on permanently when driving off-road. When switched on, the HDC functionality is provided with virtually invisible transitions between when the system is active and inactive.

The system enables the driver to maintain a target speed whilst in first or reverse gear. This is achieved by using only the throttle to maintain speed irrespective of how steep the descent is. The minimum target speed of 9.6km/h in first gear, and 6.5 km/h in reverse gear, will be maintained in circumstances where the brake and throttle pedal are released. This is provided adequate adhesion is available between tyre and road surface. If the adhesion is insufficient on one or more wheels, the system automatically operates the ABS sequence to maintain as much control as possible within the physical limits of adhesion. Application of the brakes will override the system, allowing the vehicle to be brought to a standstill if required.

The brake lights are automatically illuminated by the ABS ECU in circumstances where the HDC system is in operation regardless of the foot brake position. This serves to warn following vehicles that the brakes have been applied.

HDC is selected manually by the driver via a yellow switch and sliding collar located on the gear lever.



1. HDC Switch

Figure 62

HDC Operation

If HDC has been selected, and first or reverse gear is engaged the system will be ready to provide the HDC functionality. When HDC is required to maintain the minimum target speed, the return pump (7) is activated. The shuttle valve (2) is in its rest position and line B is open to the master cylinder (8). Fluid is drawn from the reservoir into the pump circuit and subsequently into the brakes. The inlet (4) and outlet (5) valves, in response to ECU inputs, control the pressure to the front and rear brakes.

If the brake pedal (1) is pressed whilst in active braking mode (HDC), the shuttle valve switch (3) will be triggered. This informs the ECU that the brakes have been applied, and HDC functionality will be disabled. Normal braking will be re-instated immediately.

Warning Lamp Operation

Two lamps, situated in the instrument panel are provided to inform the driver of the status of the HDC system functionality and failure. The HDC information lamp is a green lamp which shows a vehicle graphic on a slope. This lamp has two operational modes. If HDC is requested by way of the switch and first or reverse gear is not selected, the lamp will flash. This indicates that HDC has been selected, but is not operational at this stage. However, when first or reverse gear is selected, the lamp will illuminate continuously. This indicates that HDC is ready to function.

The HDC failure lamp is an amber lamp and also shows a vehicle graphic on a slope. When illuminated, the lamp indicates that a fault has been detected by the ECU. Any faults detected within the HDC system will affect the functionality of the HDC.

Warning Lamp Functionality Table

Warning Lamp	Operation
ABS (Amber)	The lamp will illuminate [for 1.3 to 2 seconds]. when the ignition is switched on The lamp will then go out for 0.5 to 0.625 seconds, and then illuminate again. The warning light will then extinguish when vehicle speed is above 7km/h. If a fault code is logged in the ABS ECU memory, the warning lamp will stay illuminated after the initial ignition- on check period. This serves to warn the driver that a fault code is logged in the system and ABS operation will be suspended.
ETC (Amber)	The lamp will illuminate [for 3 seconds] when the ignition is switched on and will then extinguish. The lamp will then illuminate continuously whenever traction control is activated by the ECU. It will illuminate for a minimum period of 2 seconds regardless of how long ETC has been operative, to warn the driver that traction control is activated.
HDC (Green)	The lamp will illuminate [for 3 seconds]. when the ignition is switched on When HDC has been selected it flash until first or reverse gear is selected. This indicates that HDC has been requested. When first or reverse gear is selected, the warning lamp will illuminate continuously to confirm HDC is ready for operation.
HDC (Amber)	The lamp will illuminate [for 3 seconds]. when the ignition is switched on It will also re-illuminate if a fault is detected in the system. When a fault is detected the green lamp will be extinguished.

Diagnosis

When the ignition is switched to position 2, the system carries out a self-test of all the major components in the ABS, HDC and ETC system. The hydraulic modulator re-circulation pump is also tested when the engine has been started and the wheel speeds have exceeded 7 km/h in the previous driving cycle. In the event of a system malfunction, a fault code will be logged in the ECU’s memory, and the relevant warning lamp will be illuminated. The fault code can be read and the system diagnosed using TestBook via the 16 pin diagnostic connector.