



DISCOVERY SERIES II

Body electrics

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Preface

This document has been issued to support the Discovery model range. The information contained within this document relates to the features and specification of this model.

Every effort has been taken to ensure the information contained in this document is accurate and correct. However, technical changes may have occurred following the date of publication. This document will not necessarily have been updated as a matter of course. Therefore, details of any subsequent change may not be included in this copy

The primary function of this document is to support the Technical Academy training programme. It ***should not*** be used in place of the workshop manual. All applicable technical specifications, adjustment procedures and repair information can be found in the relevant document published by Rover Group Technical Communication.

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Body electrics

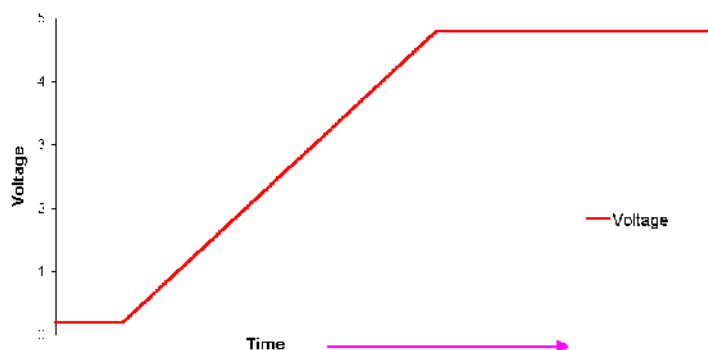
Analogue signals

Analogue signals are created by modifying battery voltage or by creating a voltage from an inductive sensor. Analogue signal can be either DC or AC.

DC signals

This can be a voltage returned from a sensor in a range between 0 - battery volts. An example of this is the throttle position sensor or the coolant temperature sensor. The range does not necessarily have to be within the range of 0 - battery volts and in most cases, the maximum voltage supplied is 5 volts. The important factor is that the signal returned is a proportion of the supplied voltage.

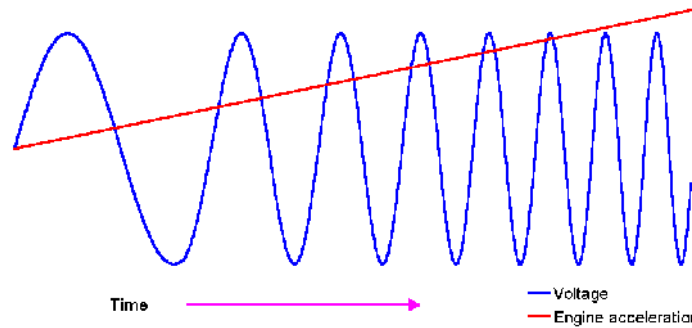
Throttle potentiometer



AC signals

An analogue signal can also be an AC signal. This means that the voltage fluctuates between a positive voltage and a negative voltage in a similar fashion to the electrical current supplied by the electricity generating companies. The signal is described as a 'sine wave'. The important factor of these signals in a motor vehicle application is not so much the voltage produced but the frequency of the wave. This is measured in waves per second (Hz). An example of this would be a crankshaft sensor. The faster the crankshaft rotates, the more quickly, and frequently the holes move past the end of the crankshaft.

Crankshaft sensor output



Logical signals

This type of signal is associated with something being switched 'on' or 'off'. An example of this is an air conditioning request. The automatic temperature control system asks the engine management system to turn on the air conditioning compressor. It does this by either supplying a voltage, or supplying a path to ground. This has implications when diagnosing electrical systems with a voltmeter. A measured voltage of 0 volts can mean that the system should be activated rather than dormant, if the controlling circuitry 'sinks' a switching voltage.

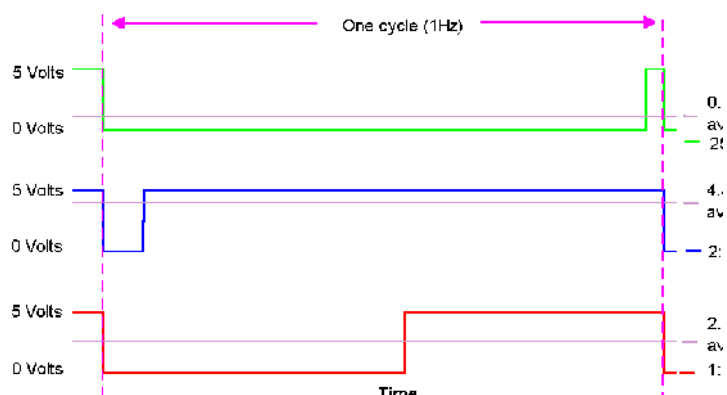
Digital signals

These signals are generally formed by electronic units and can fall into one of the following categories

PWM signal

The first type of these signals is a relatively low speed pulse width modulated (PWM) signal. PWM is a digitally constructed signal with a fixed frequency. An ECU passes information to another ECU by using only one wire. The ECU constructs a signal with a different 'period' or 'duty cycle' (the amount of time the voltage is at a high level compared to a low level). This period is derived from a number (piece of information) which the sending ECU wants to send. The ECU receiving the signal compares the amount of time that the signal is 'on' with the time it is 'off' and assigns a value to it. This value will be the same as the first number, providing the signal has not being corrupted during transfer. Another way this signal can be used by an electrical device is for it to take an average of the signal over time. A circuit which uses this type of technology will smooth the signal, using an average of the 'on' time and 'off' time. The result of this average can be used in a similar fashion to that of an analogue signal.

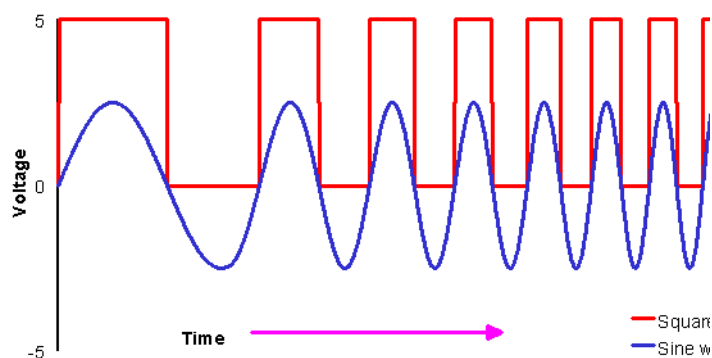
Pulse width modulation



Pulse frequency

An ECU, or other electronic device, constructs this type of digital signal. It is then transmitted to other electronic system ECU's or devices which interpret the data rate. The graph below illustrates how an ABS ECU converts an analogue signal into a frequency which it then transmits to the ECM. As the road speed increases, the frequency increases. It should be noted that this type of pulsed signal does not have to correspond directly to the AC signal used to construct it. An ECU can send just a short pulse to indicate an event has occurred. In practice, this second method of sending digital frequency dependent signals is usually the preferred method.

Frequency dependent square wave



Bus technology

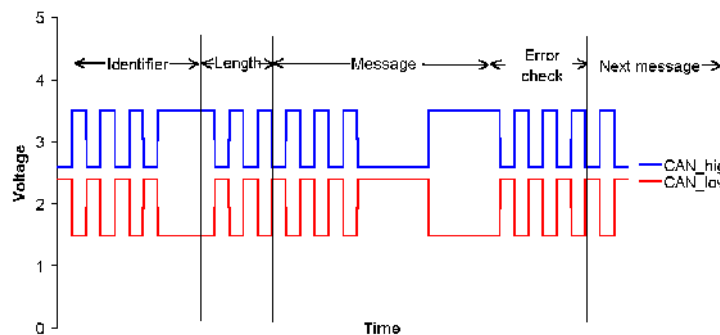
New Discovery uses three types of bus to transfer data between different ECU's:

- Controller area network (CAN)
- The body bus
- Diagnostic line (K-line)

All of these technologies are used to transmit encoded messages from one source to another. In a sense, they operate in the same manner as the postal service. Information (the letter) is electronically addressed (addressed), sent (posted), decoded at the receiving end (delivered) and checked for errors (signed for). The message can be checked by the receiving ECU because, along with the original data to be transmitted, a mathematical 'check sum' is calculated and also sent. These bus signals work at a fixed frequency, all ECU's which connect to the bus are tuned to recognise the data at that frequency. The graph below illustrates a data word that is present on the bus.

The frequency the CAN bus operates at is, 500 kilo baud (500,000 cycles per second). Compare this with the body bus which operates at 10,400 baud (10,400 cycles per second) and the K-line, which operates at 9,600 baud (9,600 cycles per second). This speed is why the CAN bus can transfer so much information between the engine management ECU and the automatic gearbox TCU. Both the CAN, body bus and K-line can send and receive data on the same line, but not at the same time.

CAN bus architecture



The CAN bus is a twisted pair of wires. The wires are matched in length and diameter. It is critical that the wires remain twisted to the correct number of turns. If not, they will produce unacceptable levels of electromagnetic radiation, adversely affecting other systems on the vehicle. The two wires carry the same signal, but are 180° out of phase. One wire is known as CAN_high, the other as CAN_low. The CAN_high wire changes from »2.5 volts up to 3.5 volts when the data bit changes from an '0' (off bit) to a '1' (on bit). At the same time, the CAN_low wire changes from »2.5 volts down to 1.5 volts. This form of signal is referred to as a differential signal, as the receiving ECU receives a voltage that varies from »0 volts to »2 volts. This, coupled with the fact the wires are twisted, reduces the electromagnetic radiation produced in any wire with a fast moving signal.

If the need arises and the harness has to be repaired, it is important that the harness is not unwound more than 3 - 4 cm. The wire should also be repaired with a crimped joint rather than a soldered one. All ECU's attached to the CAN bus have a resistor located internally on each termination of the CAN bus. These resistors stop 'electrical reflections' occurring in the wire and aid the clean delivery of the signal.

The body bus connects together the body control unit (BCU), intelligent drivers module (IDM) and the instrument pack. The K-line connects together all the ECU's on the vehicle which have the ability to communicate with TestBook. The K-line is used by TestBook to interrogate ECU's, it is not used to exchange data between the different systems. As these buses are much slower than the CAN bus, the wiring is of a more conventional design, employing a single wire to carry the signal.

Market programming and customer configuration

During the previous sections within the document, reference has been made to the market programme and customer configuration options. The BCU can be programmed to 12 different markets. It also has the ability to alter some of the functionality that the market programme allows. This change in programming is referred to as 'customer configuration'. There are two types of customer configuration:

1. CLASS (corporate locking and alarm security strategy) options
2. Non-CLASS options

TestBook can alter some of the functionality within each setting. The function of the buttons will scroll through the options available within market programme. It should be noted that, if the BCU is programmed with a different market specification, or reprogrammed with the same market specification, all customer preferences will be lost.

There are some options shown when viewing the BCU configurations from TestBook that can be changed only once. These options are set from a series of questions and information gained from the vehicle chassis number, when the BCU is first programmed to the vehicle.

Non-CLASS options

The following table lists the options available

Function	Option	Explanation
Transmission	Manual Automatic	The vehicle is fitted with manual transmission The vehicle is fitted with automatic transmission
Front fog lamps	None No main Main	The vehicle is not fitted with front fog lamps The front fog lamps will operate if the headlamps are on main beam The front fog lamps will not operate if the headlamps are on main beam
Shift interlock	None Shift No transfer	The vehicle is not fitted with a shift interlock solenoid The vehicle is fitted with both shift interlock and transfer box interlock solenoids The vehicle is fitted with a shift interlock but no transfer box interlock solenoid
Daylight running lamps	None No main No heads	The vehicle is not fitted with daylight running lights The daylight running lights are on if the main beam headlights are off The daylight running lights are on with main and dipped beam off and the gearbox not in PARK
Programmed wash wipe	Normal No wipe	The front wipers operate if the front wash is operated The front wipers do not operate if the front wash is operated
Key-in warning	Disabled Enabled	The ignition key-in warning sound is disabled The ignition key-in warning sound is generated if the ignition key is in and the driver door is open
Electric front seats	None Normal Ignition II	The vehicle is not fitted with electric front seats The electric seats are available if the ignition is on or the driver door is opened for a short time The electric seats are available if the ignition is on and the driver door is closed
Electric front windows	Driver cancel All cancel No cancel	The front windows will be disabled 44 seconds after the driver door is opened The front windows will be disabled 44 seconds after any door is opened The front windows will be disabled when the ignition is turned off
Heated front screen	None Fitted	The vehicle is fitted with heated front screens The vehicle is not fitted with heated front screens

Non-class options

The following table continues to list the options available

Function	Option	Explanation
Rear windows and sunroof	Driver cancel	The rear windows and sunroof will be disabled 44 seconds after the driver door is opened
	All cancel	The rear windows and sunroof will be disabled 44 seconds after any door is opened
	No cancel	The rear windows and sunroof will be disabled when the ignition is turned off
Autographic illumination	Always Sidelights	The automatic gearbox selector illumination is on when the ignition is on The automatic gearbox selector illumination is on when the ignition is on and the side lights are on
Hill descent control	None Fitted	The vehicle is not fitted with hill descent control The vehicle is fitted with hill descent control
Courtesy headlamps	Disabled Enabled	The vehicle is not fitted with courtesy headlamps The vehicle is fitted with courtesy headlamps
Odometer error warning	Disabled Enabled	The odometer will not flash if there is an odometer error The odometer will flash if there is an odometer error
Seatbelt warning lamp	Timed	The warning lamp is on for 6 seconds after ignition is turned on
	Buckle	The warning lamp is on for 6 seconds after ignition is turned on or until the buckle is fastened
	Ignition II	If the buckle is unfastened when the ignition is turned on then the lamp is on for 6 seconds
Bulb failure warning	Disabled	Direction indicator bulb failure detection is disabled
	Enabled	Direction indicator bulb failure detection is enabled

Class options

The following table lists the options available

Function	Option	Explanation
Superlock	None	Superlocking is not available
	Double	The vehicle will superlock on a double press of the remote transmitter or double key turn
	Single	The vehicle will superlock on a single press of the remote transmitter or single key turn
Unlock option	No key	The vehicle will superlock on a single press of the remote transmitter but not with the key
	Not SPE SPE	The SPE (single point entry) function is not used, all doors unlock on a remote transmitter press Only the drivers door unlocks on the first remote transmitter press, others on the second
Alarm disarm option	Always	Operation of the key in the drivers door always disarms the vehicle
	Key only Key never	Operation of the key in the drivers door only disarms the vehicle if it was locked with the key The security system is not disarmed by the key (except via an EKA)
Inertia switch	No hazards Hazards	Operation of the inertia switch does not operate the hazard indicators Operation of the inertia switch does operate the hazard indicators
Speed locking option	Disabled Enabled	Speed locking is disabled Speed locking is enabled. The door locks are disabled when the vehicle is moving
Volumetric option	Disabled	Volumetric sensing is disabled
	Enabled	Volumetric sensing is enabled
Alarm option	Disabled Enabled	The vehicle is not fitted with a security system The vehicle is fitted with a security system
Passive immobilisation	Disabled Enabled	Passive immobilisation is disabled Passive immobilisation is enabled
Hazards option	Disabled	The hazards do not flash on security system arm, disarm or trigger
	Enabled	The hazards flash on security system trigger only
Mislock option	All	The hazards flash on security system arm, disarm and trigger
	Disabled Enabled	Mislock audible warnings are disabled Mislock audible warnings are enabled

Class options

The following table continues the options available

Function	Option	Explanation
Alarm sounder option	Alarm Both Vehicle BBS Disabled	Audible warnings are given by the security system horn only Audible warnings are given by both the security system horn and vehicle horn Audible warnings are given by the vehicle horn only Audible warnings are given by the security system horn, vehicle horn and BBS Audible warnings are not given
Bathrobe locking option	Disabled Enabled	The vehicle cannot be locked if the ignition is on The vehicle can be locked if the ignition is on and the engine is running
Alarm tamper option	Disabled Enabled	The security system LED does not flash when the security system has been tampered with The security system LED flashes when the security system has been tampered with
Engine immobilised option	LED off LED flash	The security system LED does not flash when the engine is immobilised The security system LED flashes when the engine is immobilised
Low battery warning	Disabled Enabled	The security system LED does not flash when the remote transmitter battery is low The security system LED flashes when the remote transmitter battery is low
EKA option	Disabled Enabled No unlock	EKA (emergency key access) is disabled EKA is enabled and the door locks operate electrically EKA is enabled, but the door locks do not operate electrically

Wiper system

All derivatives within New Discovery model range are fitted with front and rear wipers. Headlamp powerwash is also standard on some models and available as an option on some others. The exact specification of each model will vary according to regional requirements (see local sales literature for full details). The following provides a full description of the wiper system.

The wiper system includes the following functions:

1. Windscreen wipe function speed I
2. Windscreen wipe function speed II
3. Flick wipe (used to operate the front wipers once only)
4. Windscreen wipe intermittent
5. Windscreen wash
6. Headlamp wash
7. Rear window wipe
8. Rear window reverse operation
9. Rear window wash (ignition II only)

In all of the above conditions (except when specified), the wiper system needs the ignition switch to be in position I (auxiliary) or position II (ignition) before the system will operate

Front wiper speed I, II and flick

The front wiper motor switch is located in the end of the steering wheel stalk (right hand side). Wiper operation is achieved by turning the end of the switch. The wiper switch controls the wiper motor directly when the driver selects continuous wipe (slow or fast) and when the driver operates 'flick' mode (pulls the switch upwards to activate single wipe). If the driver selects intermittent wipe, or wash, the BCU controls the wiper motor via the IDM. The signal used to trigger the wiper motor from the IDM is still routed through the wiper switch, to avoid the wiper motor ever receiving simultaneous signals to operate 'slowly' and 'quickly'.

Front wipers intermittent operation

The front intermittent wipe option features five pre-programmed driver-selectable delay periods. The delay periods determine how much time elapses between each single wipe operation in the intermittent mode. The shortest delay period is 3 seconds. The period is increased in 2 second increments up to a maximum of 11 seconds. The desired delay period is set by the position of the rotary switch located on the column stalk, just inboard of the wiper switch.

When the driver selects intermittent wipe (first detent), the BCU instructs the IDM to operate the wiper motor. In response, the IDM supplies power to the normal speed winding of the wiper motor for a period of time no longer than 500mS. The timed feed ensures that the wiper motor operates, but does not complete more than a single wipe of the screen. At the same time, the BCU evaluates the position of the delay switch. An internal counter, within the BCU, is set in accordance with the position of the switch. The BCU then instructs the IDM to operate the wiper motor at the frequency prescribed by the set position. This operation continues until the wiper switch is moved to the off position or to the normal or fast speed position. The delay period can be changed by altering the position of the delay switch (see description below).

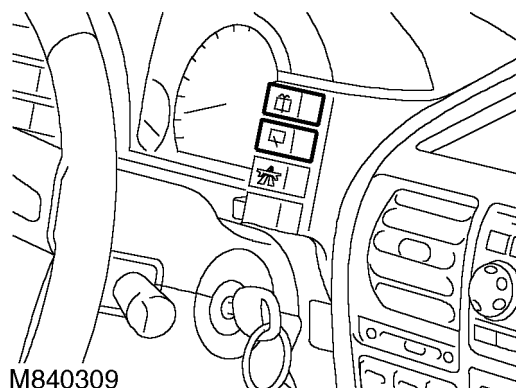
It should be noted that, each time intermittent operation is selected, a delay of 500mS will be initiated before the wipers operate. This automatic delay period prevents the occurrence of a wipe action when the wiper switch is moved to the off position from the normal or fast position.

The driver can change the set delay period by moving the delay switch to a new position. If a shorter delay period is selected, the BCU will initiate a wipe action immediately and will reset the internal counter to the new value. It will then operate intermittent wipe using the new delay value. If, on the other hand, the driver moves the delay switch to a position that lengthens the delay period, the BCU initiates the revised delay period immediately.

Front and rear windscreen programmed wash

The front wash switch is located on the wiper stalk, the rear wash switch is located in the instrument pack surround. They are both momentary switches (do not stay in when released). The way the vehicle reacts to the driver pressing the front or rear windscreen wash switch depends upon a configurable setting programmed within the BCU. There are two options:

1. No wiper operation when the wash switch is pressed
2. Wiper action after an initial delay of 400mS



Assuming the vehicle is configured to operate the wipers when the washer button is pressed, the wipers will trigger 400mS (0.4 seconds) after the washer pump becomes active. If the washer switch is released before 400mS, the wipers will not operate. After the initial delay of 400mS the wipers will operate for the period that the washer switch is depressed, plus an additional 4 seconds.

Headlamp power wash

Vehicles fitted with a headlamp power wash system need to be configured by TestBook, either at the point of build or retrospectively if the system is fitted after manufacture or a new BCU is fitted. The headlamp wash is activated by the BCU, via the IDM. It will operate the washers only if the headlamps are on (dipped beam or main beam) and then only every third time the front windscreen wash button is pressed. When the BCU operates the headlamp washers, it activates the washer pump relay for a period of 500mS (0.5 seconds).

Rear window wipe

The rear window wiper switch is located in the instrument binnacle surround. The switch is of the latching type and will operate the rear wiper via the BCU and IDM. The BCU controls the wiper operation according to a pre-programmed strategy.

The rear wiper motor is operated initially for a continuous period of 4 seconds when the switch is pressed. After this, the rear wiper will operate every other time the front wiper completes a sweep of the windscreen. The front and rear wiper motors operate at the same speed ('normal speed' front wiper operation). This feature enables the BCU to synchronise the front and rear wipers and control their operation, as described above.

When intermittent wipe is selected, the rear wiper continues to operate in synchronisation with the front wipers, i.e. operates every other time the front wipers complete a single sweep. Changes to the front wiper delay period will alter rear wiper operation in line with the effect on the front wipers.

Reverse gear wipe

The BCU changes the operation of the rear wiper when the front wiper is active and reverse is selected. The rate the rear wiper operates, when the above conditions are met will depend on the current front operating mode of the front wipers and the position of the rear wiper switch.

If the rear wiper is on or the front wiper is currently operating at an intermittent rate and the driver selects reverse gear, the BCU will operate the rear wiper continuously for 4 seconds via the IDM. After this initial period, the rear wiper will operate at the same rate as the front wiper, i.e. at twice its normal delay.

If the front wiper is currently operating at speed 1 or speed 2, the BCU will continuously operate the rear wiper via the IDM.

In both of the above situations the BCU will delay the operation of the rear wiper by a period of 500mS. This delay ensures the rear wiper does not operate when the gear lever is moved from 'park' to 'drive' on automatic vehicles.

Front and rear fog lamps

Front fog lamps are standard equipment on some New Discovery derivatives and are optional on most other derivatives (see local sales literature for full specification data). In cases where front fog lamps are fitted, the BCU controls their operation via the IDM. Land Rover engineers have made the operation of the front fog lamps programmable, to accommodate the legislative requirements of individual markets. The options are:

1. The vehicle is not fitted with front fog lamps
2. The front fog lamps operate when the headlamps are dipped or are on main beam
3. The front fog lamps will not operate if the headlamps are on main beam

The rear fog lamps are standard on all build specifications. Both the front and rear fog lamps switches are momentary switches. The BCU will operate the fog lamps via the IDM when the appropriate conditions are met. If those conditions are no longer current (i.e. the driver switches off the headlamps or ignition), the BCU will not operate the lamps again until the conditions needed for operation are met and the driver presses the switch again.

Daylight running lamps

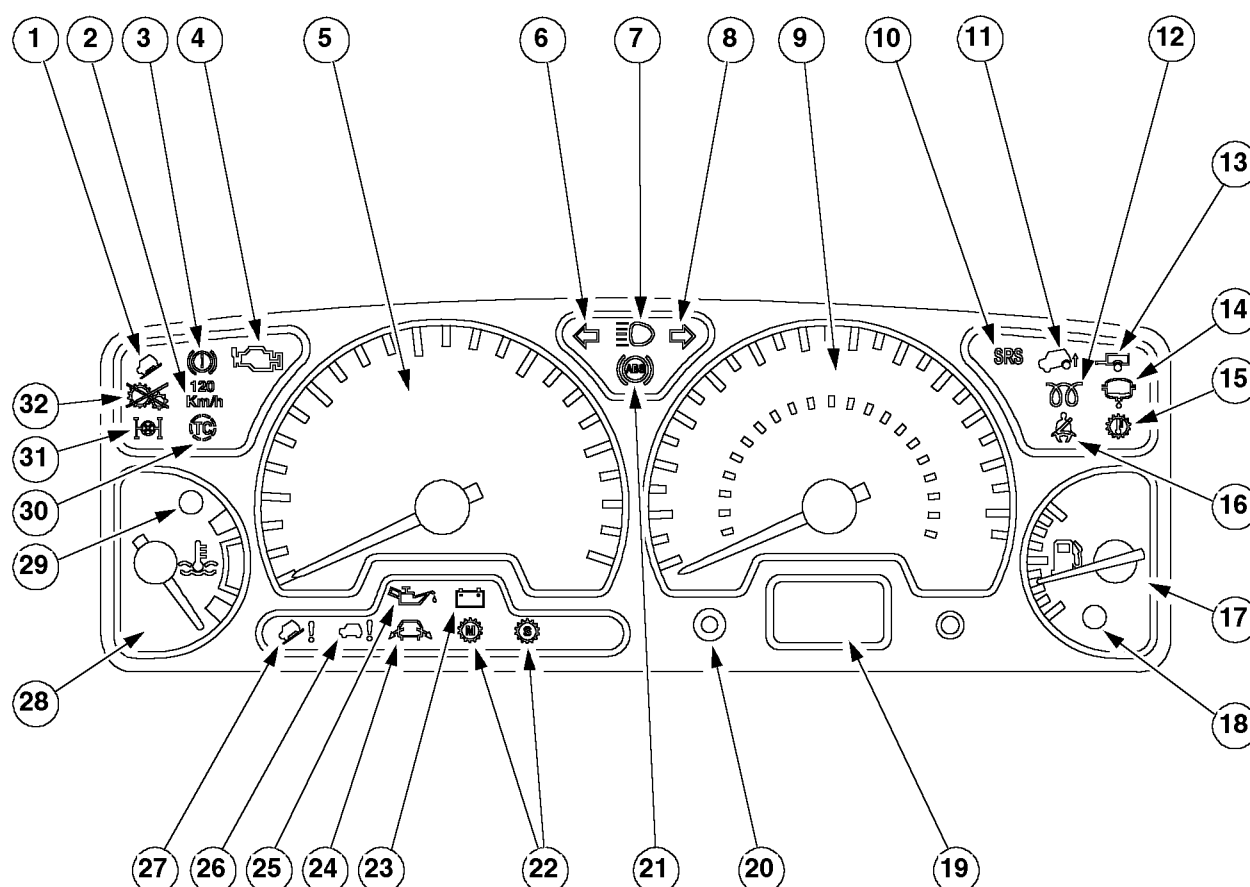
Legislation in some markets requires that the headlamps illuminate whilst the vehicle is moving, or the ignition is switched on. This function is referred to as 'daylight running lamps'. Therefore, the BCU, which controls illumination of the headlamps, must also be programmed to accommodate the legislative requirements of individual markets, with regard to daylight running lamps. The options are:

1. The vehicle does not require the daylight running lamp feature to operate in any circumstance
2. The daylight running lamps will be on if the main beam headlamps are off
3. The daylight running lamps will be on whenever the main or dipped beam headlamps are switched 'off' and the gear selector lever is in any position other than 'park'

Instrument pack

New Discovery incorporates a completely new instrument pack. It is located within a binnacle on the fascia. Each instrument pack features the following:

1. 4 Dials (gauges and pointers)
2. 28 Driver information lamps (grouped into 4 areas)
3. LCD display (incorporating the odometer, selected gear (automatic only) and trip odometer)
4. A sounder



M180329

- | | |
|--|--|
| 1. Hill descent control information warning lamp | lamp |
| 2. Overspeed warning lamp | 16. Seat belt warning lamp |
| 3. Brake system warning lamp | 17. Fuel tank level gauge |
| 4. Malfunction Indicator Lamp (MIL) | 18. Low fuel level warning lamp |
| 5. Tachometer | 19. LCD odometer/trip meter |
| 6. Direction indicator warning lamp | 20. Anti-theft status warning lamp |
| 7. Main beam warning lamp | 21. ABS warning lamp |
| 8. Direction indicator warning lamp | 22. Gearbox manual/sport mode warning lamp |
| 9. Speedometer | 23. Alternator charge warning lamp |
| 10. SRS warning lamp | 24. ACE warning lamp |
| 11. Off road mode warning lamp | 25. Oil pressure warning lamp |
| 12. Glow plug warning lamp | 26. SLS warning lamp |
| 13. Trailer warning lamp | 27. Hill descent control warning lamp |
| 14. Water in fuel filter warning lamp | 28. Engine coolant temperature gauge |
| 15. Transmission high temperature warning | 29. High coolant temperature warning lamp |
| | 30. Traction control warning lamp |
| | 31. Differential lock warning lamp |
| | 32. Transfer box neutral warning lamp |

A number of different instrument packs are available to suit the wide variety of regional requirements. The precise number and function of the warning lamps and configuration of the speedometer are the main differences between the assemblies available. The precise specification of the vehicle will determine which instrument pack is fitted

The instrument pack communicates with a variety of different ECU's on the vehicle. It is capable of processing information supplied in analogue, digital, PWM, pulse train and serial communication form. As well as communicating with other ECU's, it is connected with the body BUS, along with the BCU and the IDM.

The instrument pack also receives, and can process, information related to the regional and vehicle specification supplied by the BCU. This capability enables it to identify the engine and transmission type, the chassis systems configuration and programmed regional specification.

Dials

The instrument pack features four dials to give the driver an indication of the current vehicle status. The dials are:

1. Speedometer
2. Tachometer
3. Fuel gauge
4. Temperature gauge

The instrument pack and remote switches illuminate their displays when the driver switches on the headlamps or side lamps. The level of illumination in most markets is preset.

The speedometer registers the vehicle speed when it is in excess of 2 km/h (1.3 m.p.h.). The instrument pack receives a pulse stream from the SLABS ECU equivalent to 8,000 pulses every mile. The signal is processed into a signal which drives the speedo pointer. It should be noted that a slow frequency is always sent from the SLABS ECU when the vehicle is stationary.

This instrument pack requires the signal to verify that the connection from the SLABS ECU is intact.

The instrument pack transmits the vehicle speed to the IDU and the BCU.

There are three speedometers available for derivatives of New Discovery. Each one features a different graphic display. The options are as follows:

- The major scale features miles per hour, the minor scale kilometres per hour
- The major scale features kilometres per hour, the minor scale miles per hour
- The major scale features kilometres per hour and there is no minor scale

The tachometer, which is located to the left of the speedometer in the instrument pack, displays engine speed between 228 – 6,000 rev/min. In operation, the instrument pack receives a pulse stream signal from the ECM. The signal supplies 2 pulses for every 360° of engine rotation. The signal is processed by the instrument pack and converted into an output to drive the tachometer pointer.

A signal is also supplied to the instrument pack from the ECM in circumstances where the engine is stopped but the ignition is on. This signal is supplied in the form of a pulse stream at a 'slow' frequency. This signal is used to ensure that the connection between the ECM and the instrument pack is intact.

The fuel level gauge, located to the right of the speedometer within the instrument pack, provides an analogue indication of the quantity of fuel present in the fuel tank. The position of the gauge is set in response to an input received from a sender unit, located within the fuel tank. In operation, the position of a float arm, incorporated into the sender unit, is determined by the amount of fuel in the tank. In turn, the sender unit supplies a variable voltage signal to the instrument pack. The signal value is determined by the precise position of the float arm. The gauge will register fuel level as long as the resistance of the sender unit is between 8 – 550 Ohms. The instrument pack 'damps' the signal received from the fuel gauge to limit the rate of change displayed on the gauge. This feature stops the gauge moving dramatically when fuel is sloshing around the tank. It should be noted that, when the ignition is switched on, the instrument pack inhibits this damping feature, so an immediate response can be achieved.

The coolant temperature gauge is driven from the instrument pack. The ECM sends a PWM signal to indicate the temperature of the engine. This signal is processed into increments. The temperature gauge has been designed in this manner to eliminate unnecessary movement when the engine experiences normal variations, due to the position of the thermostat and the load currently being experienced by the engine. Therefore, it should be noted that there is no direct correlation between the exact engine temperature and the gauge reading.

Driver information lamps

There are 28 different driver information lamps located within the instrument pack. Although referred to as 'lamps' it should be noted that with the exception of the main beam warning lamp, all are LED's (light emitting diodes). These are 'hard wired' into the instrument pack and cannot be serviced separately. The main beam warning lamp can be replaced in service, if required.

The exact functionality of each lamp is described within the relevant system description sections, incorporated in this document. Details of lamp functionality can also be found in the owners handbook. The following tables describe the meaning and colour of each warning lamp. In addition, they provide supplementary information not found elsewhere in this document.

Group 1

Name	Colour	Bulb check	Note
Directional indicator	Green LED	No	Signal originates from the IDM, TestBook can operate this lamp
Directional indicator right	Green LED	No	Signal originates from the IDM, TestBook can operate this lamp
Main beam	Blue lamp	No	Driven directly from the fusebox. The instrument pack has no control over this lamp
ABS	Yellow LED	Yes, by system	TestBook can operate this lamp

Group 2

Name	Colour	Bulb check	Note
Oil pressure LED	Red	No	Direct input from oil pressure switch. TestBook can operate this lamp
Alternator charging	Red LED	No	Direct from the alternator. This lamp can be operated by TestBook
HDC	Yellow LED	Yes by system	TestBook can operate this lamp
SLS	Yellow LED	Yes by system	TestBook can operate this lamp

Body electrics

Name	Colour	Bulb check	Note
ACE	Yellow or red LED	Yes by system	TestBook can operate this lamp
Transmission manual	Green LED	Yes	TestBook can operate this lamp
Transmission sport	Green LED	Yes	TestBook can operate this lamp

Group 3

Name	Colour	Bulb Check	Note
HDC	Green LED	Yes, by system	TestBook can operate this lamp
Brake system	Red LED	Yes, by system	TestBook can operate this lamp
Check engine	Yellow LED	Yes, by system	TestBook can operate this lamp
Transfer box in Neutral	Red LED	Yes by BCU	Japan, NAS and Canada specification only, TestBook can operate this lamp
120 km/h	Yellow LED	No	Gulf specification only TestBook can operate this lamp
Centre Differential Lock	Red LED	No	Direct input from the transfer box switch
Tc	Yellow	Yes, by system	TestBook can operate this lamp

Group 4

Name	Colour	Bulb check	Note
SRS	Red LED	Yes, by system	TestBook can operate this lamp
Off-road/vehicle jacking	Yellow LED	Yes, by system	TestBook can operate this lamp
Trailer	Green LED	Yes, by BCU	This operates when the IDM senses that the current drawn by the indicator circuit exceeds a given threshold. TestBook can operate this lamp
Glowplug	Yellow LED	Yes, by system	TestBook can operate this lamp
Water in oil	Yellow LED	Yes, by system	TestBook can operate this section
Seat belt warning	Red LED	Yes	Operates for 6 seconds unless the seatbelt is successfully connected. TestBook can operate this lamp
Transmission temperature	Red LED	Yes	Direct input from switch. TestBook can operate this lamp

LED displays

Name	Colour	Bulb Check	Note
Alarm	Red LED	No	
Low fuel	Yellow LED	Yes	Bulb check cancelled if the engine is running. TestBook can operate this lamp
High temperature	Red LED	Yes	Bulb check cancelled if the engine

LCD display

The LCD display is used to display the odometer reading, the trip reading and, on vehicles equipped with automatic transmission, the current gear position selected.

The odometer reading is calculated from the data supplied from the SLABS ECU regarding road speed. The reading is stored digitally in a non-volatile memory incorporated within the instrument pack and in a non-volatile memory incorporated within the BCU. A value up to 999999 units, (either kilometres or miles) can be stored. Whenever the ignition is turned from position I to position II, the instrument pack and the BCU compare their stored values. If the instrument pack detects that the values are different, it will 'flash' the odometer. The odometer will continue to flash until the values have been synchronised. Both units continue to record any distance travelled by the vehicle, even when the display is flashing. If the need arises to change either the BCU or the instrument pack, the new unit will require synchronisation with the existing unit. The value can be synchronised only in an upward direction (the higher of the two values is stored in both units, with the one exception detailed in the next paragraph). Synchronisation of the values can be achieved using TestBook.

If necessary, the odometer readings stored by the BCU and the instrument pack can be reset to 0 kilometres (0 miles) using TestBook. This operation can be carried out only once and then only in circumstances where the current reading is below 160 kilometres (100 miles). This feature is designed to provide dealers with the opportunity of delivering New Discovery vehicles with 0 kilometres (0 miles) displayed on the odometer. This can be carried out after the pre-delivery inspection, once the delivery mileage has been recorded. It should be noted that the values stored by the BCU and the instrument pack must be reset. If only one value is reset then the odometer will flash a miss-match warning, as previously described (depending upon market specification).

The trip reading feature will record the vehicle kilometres/miles to a resolution of 0.1 unit, up to a maximum reading of 999.9 kilometres/miles. When this value is reached, it 'rolls over' to 0 kilometres/miles. A button is provided to reset the trip reading to 0. The driver can also change the units from kilometres to miles and vice versa, by pressing and holding the trip reset button for longer than 2 seconds (only available on certain market specifications).

The gear position display, exhibits the following:

- P Park
- N Neutral
- R Reverse
- D Drive
- 3 Gears 1-3 available
- 2 Gears 1-2 available
- 1 Only 1st gear available

The 'sport mode' and 'manual mode' functions are displayed using dedicated driver information lamps. It should be noted that, if the link between the instrument pack and the BCU fails, the gear selection display will flash, to indicate to the driver that there is a fault.

Sounder

The sounder is controlled by the instrument pack, although its operative state is determined by the BCU or IDU.

Fuel contamination monitoring system

The Diesel derivatives of New Discovery feature a fuel contamination sensor housed in the bottom the primary fuel filter. The sensor monitors the amount of water contamination of the diesel fuel. The sensor will supply a signal to the ECM which, in turn, signals the instrument pack to warn the driver that the fuel contamination has exceeded a predetermined level.

Windows and sunroof inputs

New Discovery window lift system and sunroof system incorporates front and rear electric windows and two optional electric sunroofs. The front windows are controlled by the BCU, while a hard-wired circuit controls the rear windows. A sunroof ECU, which is enabled by the BCU, controls sunroof operation.

The window lift system and sunroof system receives inputs from the vehicle's driver and passengers. The BCU, via the IDM, and sunroof ECU control the window and sunroof motors by processing these inputs. Figure 30 illustrates how the system inputs interconnect.

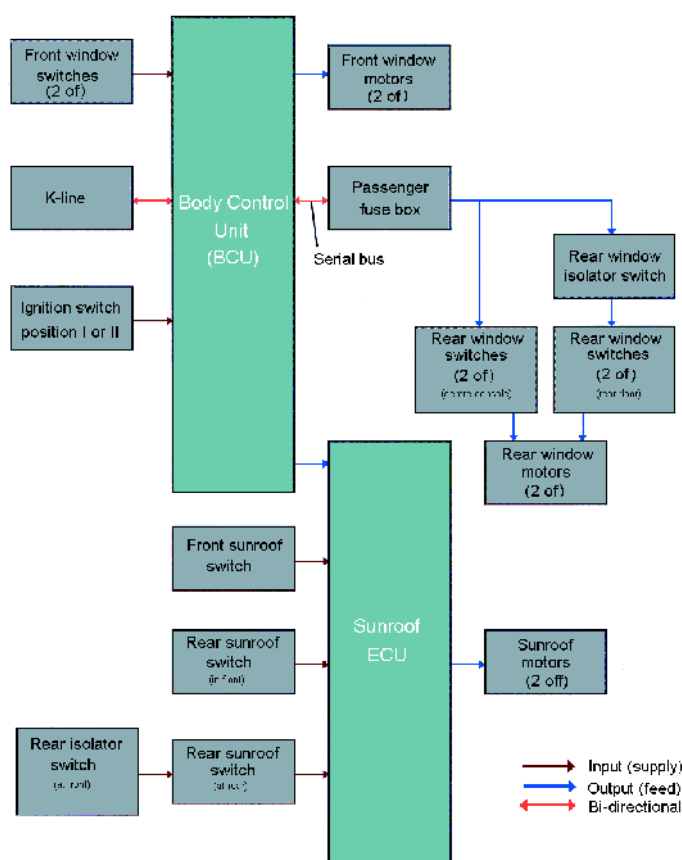
Window and sunroof system inputs:

- Ignition switch (ignition I, II)
- Front window console switches (left and right)
- Front sunroof switch
- Rear sunroof switches (front & rear)
- Rear sunroof isolator switch
- Sunroof micro-switches

There are three hard-wired parts to the window circuit. These are:

- Rear window lift on-console switches (left and right)
- Rear window disable switch
- Rear window lift on-door switches (left and right)

Electric Windows and Sunroof Block Diagram



Ignition switch

The BCU will allow window and sunroof operation when the ignition key is in position II. The BCU also keeps the window system and sunroof system active for a period of time after the ignition has been switched off. The length of this time period, and the conditions which need to be met before the BCU will allow the windows to operate after the ignition is switched off, are described later in this section.

Front window console switches

The window lift switches are located in the centre console in front of the handbrake. The front window switches are the lower two within the switch pack. The front window switches are momentary switches (will change state when pressed and return to the neutral position when released). The switches provide a path to ground from a voltage supplied by the BCU.

TestBook can be used to monitor the operation of the front window switches. Figure 31 identifies the position of the front and rear switches within the vehicle.

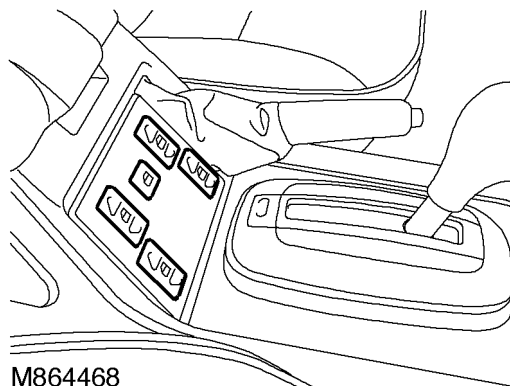
Rear window console switches and rear door switches

Each of the rear windows can be operated from either one of the two switches. One switch is located in the centre console switch pack in front of the handbrake lever (top switches), the other switch is located on the rear door casing relating to that particular window. All the window switches are momentary switches. The following graphic identifies the rear switches from the centre console switch pack.

Rear window operation is not controlled by the BCU, so the switches in the centre console and the rear doors operate the rear window motors directly. The BCU can, however, block the operation of the windows by requesting the IDM to remove the power feed to the system. This has implications when diagnosing for any failures within the rear windows system, as TestBook cannot diagnose any faults or monitor the position or operation of any of the switches, except for the inhibit signal.

Rear window disable switch

The rear window disable switch is located in the same switch pack as the front and rear window switches. It is a latching switch so remains in either the rear window enable position, or the rear window disable position. The disable switch allows rear passenger compartment window switches to operate when it is latched in. This switch has no input into the BCU so no TestBook diagnostics are available.



Sunroof switches

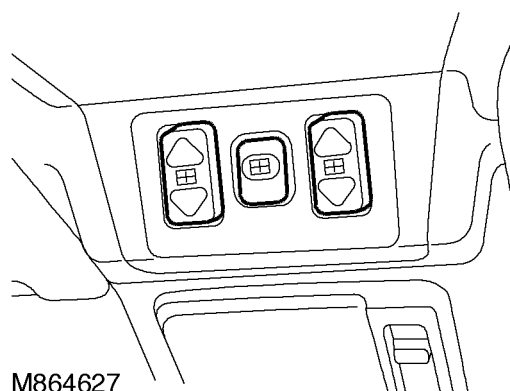
The front and rear sunroof switches are located in the headlining above the windscreen, in front of the front sunroof. The second rear sunroof switch is located by the rear sunroof. All the sunroof switches are momentary switches and interface directly with the sunroof ECU. The BCU provides an enable/disable input into the sunroof ECU. TestBook cannot communicate directly with the sunroof ECU, so the front or rear sunroof switches status cannot be viewed within the window diagnostic features in TestBook.

Rear sunroof isolator switch

The rear sunroof isolator switch is located next to the front sunroof switch in the headlining by the front sunroof assembly. It is wired in series with the rear sunroof switch, located next to the rear sunroof. The switch toggles its outputs i.e. the switch latches in the enable position. When depressed the rear switches are enabled. The following graphic identifies the position of this switch.

Sunroof micro-switches

The micro-switches are located within the sunroof assemblies. The sunroof assemblies incorporate two micro-switches to detect that the sunroof has reached its fully closed position. The sunroof ECU monitors both micro-switches individually. This enables it to determine the direction in which the sunroof has moved.



Windows and sunroof outputs

The BCU and sunroof ECU process the above system inputs and use this information to control the following items:

- Front window lift motors (left and right)
- Front sunroof motor
- Rear sunroof motor

Front window lift motors

The front window motors are located in the front door. They are connected directly to the BCU by two wires. The BCU powers one wire, whilst supplying a path to ground for the remaining wire. This configuration allows the motor to be driven in either direction by the BCU. This is achieved by the BCU reversing the wire to which it supplies a voltage and the wire to which it supplies a path to ground.

TestBook has the ability to 'force' the front motors to operate in either direction. This can be useful when diagnosing the failures within the window circuit.

Sunroof motors

The sunroof motors are located in the front and rear sunroof assemblies. Each sunroof motor is connected to the sunroof ECU by two wires. The sunroof ECU powers one wire, while supplying a path to ground for the other wire. This configuration allows the motor to be driven in either direction in a similar manner to that of the window motors. The BCU supplies the sunroof ECU with an 'enable'/'disable' signal. The enable signal is generated whenever the front windows are enabled.

Window operation

The front windows on New Discovery are controlled by the BCU. The BCU monitors the amount of current the motors are drawing during operation. The BCU can determine if the window is in a 'stall' condition. If the BCU determines that the window has 'stalled' it will immediately stop operating the window motor. The BCU will not attempt to detect a 'stall' condition until the window has been operated for at least 500mS (0.5 seconds). This period allows the initial current surge to pass and eliminates false window 'stall' detection. A 'stall' condition is defined as the motor current exceeding a nominal current value for a period of greater than 300mS (0.3 seconds).

If the BCU determines that it has been operating the same window motor in one direction for more than 10 seconds $\pm$ 0.2 seconds, without the BCU detecting a 'stall' condition or the driver releasing the switch, it will automatically stop operating the window motor.

Window operation will resume when the window switch is released and pressed again. If the window was operating in one-touch mode the window operation will resume on the next press of the window switch.

When the window switches are operated up or down, the BCU will follow a predetermined strategy. This strategy is dependent upon the market specification programmed into the BCU. Different countries have different legislation concerning automatic operation of vehicle windows. To accommodate this, New Discovery has the ability to change the way the front windows operate.

One-touch function

One-touch mode automatically lowers the window to its fully open position, without the need for the vehicle switch to be depressed for the duration of travel. One-touch mode is initialised if the window switch is operated (in the direction that will lower the window) for a period of less than 0.4 seconds $\pm$ 0.2 seconds. One-touch mode continues to lower the window until the BCU detects:

1. That a 'stall' condition exists (window reaches the bottom of its travel)
2. The driver or passenger has operated the window switch in either direction for more than 0.4 seconds $\pm$ 0.2 σεχονδος, ορ τηε ωινδω σωιτχη ηασ βεεν οπερατεδ to reverse the windows travel to an upward direction
3. The BCU has operated the motor for a period greater than 10 seconds $\pm$ 0.2 seconds

Time-out function

The time-out function enables the windows to operate after the ignition key has been removed. It is enabled for a period of 44 seconds $\pm$ 1 second, and will operate if the market specification permits its function.

The time out function will be cancelled if:

1. The driver's door switch signals the BCU that it has seen the driver's door close after the ignition is switched off (depending on market specification)
2. Any door switch signals the BCU that it has seen any door open after the ignition is switched off (depending on market specification)

Depending upon market specification, New Discovery will adopt one of the strategies detailed in the table below.

Option	Time-out on drivers door	Time-out on any door	Front windows operating
1	Yes	No	Yes
2	Yes	Yes	Yes
3	No	No	No

Rear window and sunroof operation

The use of enable lines limits the windows and sunroof to operate only when the front windows operate. The enable lines can be programmed to follow the market specification detailed above. The differences in operation are detailed in the table below.

Option	Time-out on drivers door	Time-out on any door	Rear windows operating	Sunroof operating
1	Yes	No	Yes	Yes
2	Yes	Yes	Yes	Yes
3	No	No	No	No

Vehicle security

New Discovery features a sophisticated security system designed to deter unauthorised entry into the vehicle and prevent the vehicle from being driven away illegitimately. The security system complies fully with all legislative requirements of all of the World Markets in which it is sold. The security system is currently being assessed against the criteria for class 1/2 approval from Thatcham (a professional organisation sponsored by insurance companies to assess the risk of vehicle theft).

The security system incorporates:

- Perimetric protection, which protects the vehicle by monitoring all of the hinged panels
- Volumetric protection, which protects the vehicle by monitoring its interior space
- Remote locking, superlocking and unlocking functions
- Passive engine immobilisation
- Friendly engine remobilisation
- Advanced mislock detection and automatic compensation
- EKA (emergency key access code) functions
- Customer configuration options
- Market configuration options

The body control unit (BCU) incorporates the security system as one of its functions. The BCU controls or accepts inputs from other electrical systems or components so that it can process the current status of the vehicle and the driver's demands with respect to the security system.

System inputs

The BCU processes information from the following:

- Door latch switches
- Driver's door key lock / unlock switches
- Bonnet activated security system switch
- Volumetric sensors
- Central door locking switches (CDL)
- Remote transmitter
- Receiver unit
- Other system inputs
- Ignition switch

Door latch switches

The BCU uses the door latch switches to indicate if a door is open or closed. There is a door latch switch within every door latch assembly, including the tail door. The only hinged panel with does not incorporate a door latch switch is the bonnet.

The BCU provides power to all of the door latch switches. The door latch switches are normally in an 'open' state when the door is closed. If a door is opened, the feed supplied by the BCU is allowed to go to ground. This signals to the BCU that a change of state has occurred (i.e. door has opened). These switches are connected in parallel, except for the driver's door switch. If any door is opened, except the driver's door, the BCU will recognise the switch input 'change state' but will not be able to derive from the signal which door has caused it. The driver's door latch switch has a dedicated wire from the BCU, which enables the BCU to 'know' if the drivers door is open or closed.

TestBook has the ability to monitor the state of the door switches within the real time monitoring feature in the security section.

Driver's door key lock and unlock switches

The BCU uses the driver's door key lock and unlock switches to activate and deactivate the security system (the degree of deactivation will depend upon the programmed market). These switches are also used when the emergency key access code (EKA) is entered. Two separate switches are incorporated into the key lock assembly of the driver's door. The BCU provides a voltage to each of the switches individually, in a similar manner to that of the door latch switches (e.g. the BCU is signalled when the supplied voltage goes to vehicle ground). This enables the BCU to determine in which direction the lock has been turned.

TestBook has the ability to monitor the operation of the door lock switches, within the real time monitoring feature in the security section.

Bonnet activated security system switch

The BCU uses a plunger type switch to determine when the bonnet is open. The switch is located under the bonnet on the right-hand side, when viewed from the front of the vehicle.

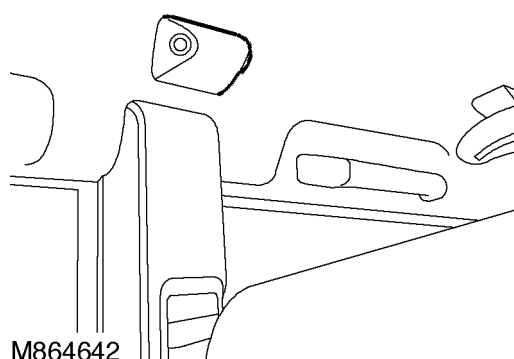
The bonnet switch is powered by the BCU. When the bonnet is closed the switch is in an open state. When the bonnet is released from its catch the switch changes state, providing a path to ground for the signal from the BCU.

TestBook has the ability to monitor the operation of the bonnet switch, within the real time monitoring feature in the security section.

Volumetric sensors

The BCU uses volumetric sensors to detect any change in air movement inside the vehicle. New Discovery incorporates two volumetric sensors located in the vehicle's headlining, one at the rear of the vehicle behind the 'D' post, the other above the 'B/C' post on the opposite side to the rear sensor.

TestBook has the ability to monitor the operation of the volumetric switch, within the real time monitoring feature in the security section.

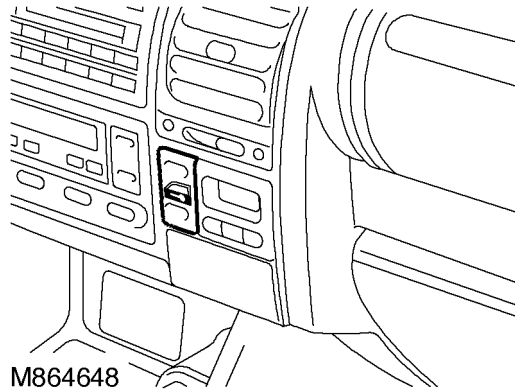


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Central door locking switches

New Discovery incorporates one momentary action dual direction central door locking (CDL) switch. The switch is mounted on the fascia panel to the side of the clock.

The switch has two inputs into the BCU, one for lock, one for unlock. TestBook has the ability to monitor the operation of the switch in both directions, within the real time monitoring feature in the security section.



Remote transmitter

The two remote transmitters are incorporated into the vehicle ignition/door keys (one transmitter for each key supplied). The remote transmitter uses coded radio frequency signals to lock, unlock and superlock the vehicle. The remote transmitters have two buttons. One button unlocks the vehicle (see section on security system configuration), the other locks or superlocks the vehicle. The remote transmitter will transmit successfully within a range of approximately 10 metres (33 feet) of the vehicle.

Receiver unit

The receiver unit is located above the vehicle's headlining, behind the rear sunroof aperture. The receiver receives all the signals the remote transmitter transmits, then decodes the signal and sends a 'square wave' equivalent of the received signal to the BCU for processing.

TestBook has the ability to monitor the operation of the remote transmitters and receiver unit within the real time monitoring feature in the security section.

Other switched inputs

A 'key in' signal is supplied to the BCU whenever the ignition key barrel is pressed 'in'. The ignition barrel moves slightly 'in' when the key is entered into the barrel. The presence of the key in the barrel will lock the barrel in the depressed position. The ignition barrel will move back only when the key is completely removed.

The engine inertia cut-off switch is monitored by the BCU. If the engine is running and the doors are in a locked state, the BCU will unlock all doors if it 'sees' the inertia switch trip, and will turn on the hazard lights if this feature has not been disabled within the customer configuration options.

The BCU monitors the ignition switch. The BCU will alter its operation when it detects the ignition switch change 'state' (move from one position to another). The BCU will trigger the alarm if it detects an ignition signal before it receives a valid disarm signal.

System outputs

The BCU processes the above signals. Depending upon the current operating status of the security system, the current user configuration of the security system and which market programme the vehicle is currently using, the BCU will activate the following items:

- Volumetric power supply
- Door actuators
- Passive coil
- Battery backed sounder (BBS)
- Vehicle horn
- Alarm horn
- Hazard warning lamps
- Security system light emitting diode (LED)
- Starter relay
- Fuel flap release actuator
- Courtesy lamps
- Headlamps
- Engine management system (EMS)

BCU

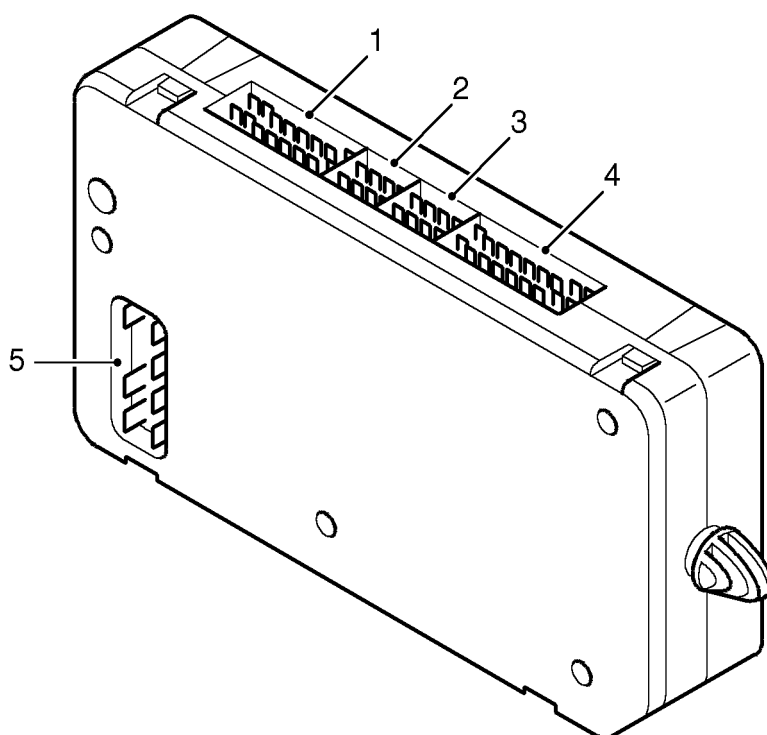
The BCU is located behind the passenger glovebox. One of its functions is to control the vehicle's security system. The BCU processes the information received from the various input devices, and controls various outputs in accordance with the programmed strategy.

The BCU receives its power from the under-bonnet fuse box. It also controls most of the devices through the intelligent drivers module (IDM). Between the IDM, instrument pack and BCU there is a data link. This data link is referred to as a 'low speed body bus' and is capable of transmitting messages bi-directionally at a rate of 10,400 bits per second. The bus transfers messages between all three members.

The BCU remembers the status of the security system when it powers down, or if it losses its battery supply. If the security system was in a set condition when battery voltage was lost, the BCU will trigger the alarm device and give visual warning by flashing the hazard lamps when it next receives battery voltage.

The BCU will activate the alarm devices if it detects a condition that violates any of the protection strategies currently being employed. It will activate the alarm devices for a period of 30 seconds, then reset. The BCU will do this 10 times (once if the market programme is set for Hong Kong). After this it will not respond to triggering events. When the BCU receives a valid unlock signal, the counter is reset. Even if the BCU does not respond to a triggering event, the BCU will still provide the vehicle with the security features enabled by the locking condition and the programmed market.

The vehicle Body Control Unit



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- 1.Connector C0661
- 2.Connector C0662
- 3.Connector C0663
- 4.Connector C0660
- 5.Connector C0664

It is not possible to communicate with the BCU via TestBook when the security system is active (except for passive immobilisation). This ensures that no key programming or market configuration can take place if the operator is not in possession of a valid remote transmitter or the vehicle keys.

The BCU is programmed to accept two remote transmitters when it leaves the factory. A further two remote handsets can be programmed into the BCU and one optional self levelling suspension (SLS) transmitter. All remote transmitters are needed if TestBook changes the BCU programme for any one of them.

Intelligent driver's module

The IDM is located within the fuse box located under the steering column. The IDM, as previously mentioned, communicates with the BCU via a serial link. This link also allows the IDM to become part of the security system. If the BCU or IDM is replaced, both units will need to re-establish communications. TestBook can program this procedure or it will happen without intervention if the ignition is switched 'on' and 'left on' for 5 minutes. The vehicles immobilisation will not be removed until one of these two procedures has been followed.

Door lock actuators

The door lock actuators are an integral part of the door latching assembly. They all have the facility to 'superlock' (superlocking is when the inside door handles and sill buttons are disabled). The BCU controls the driver's door separately from other doors. This enables functions like single point entry and key access. All the door lock actuators are controlled by the BCU via the intelligent driver's module (IDM).

TestBook can drive all the door actuators to test their functionality. It can lock, superlock and unlock all the doors.

Passive coil

The passive coil is located around the ignition key barrel. When the BCU detects that the ignition key has moved to position III and the vehicle's immobilisation system is activated, it will supply a voltage at a frequency of 125 kHz. This voltage powers the passive coil. The coil will produce a varying magnetic field, which will radiate within close vicinity of the ignition key barrel. The magnetic field transmitted by the coil triggers the remote transmitter to transmit a remobilisation signal.

Battery backed sounder

The Battery Backed Sounder (BBS) is located inside the exterior body panel near the fuel release solenoid. The BBS is a warning device for cases where the alarm is activated or the battery is disconnected. It has a self-contained power source, allowing it to operate when the vehicle battery is disconnected, or the unit is unplugged.

The BBS will not sound if the battery is disconnected and the security system is not active. This feature negates the need for a disconnection sequence, previously needed on pre 1999MY models.

The battery backed sounder utilises a 12 volt power supply from the interior fusebox. This feed provides power for the sounder and is used to charge the internal battery.

Vehicle horn

Depending on the programmed market, the vehicle horn will either sound independently or in conjunction with the alarm horn. If the alarm is triggered, the vehicle horn operates at 250mS intervals, in phase with the hazard lamps.

Alarm horn

Depending on the build specification, New Discovery will be fitted with a BBS or alarm horn. The alarm horn will sound either independently or in conjunction with the alarm horn. If the alarm is triggered, the vehicle horn operates at 250mS intervals, in phase with the hazard lamps.

Hazard lamps

The BCU controls the operation of the hazard warning lamps by signalling the IDM to operate their relay. The hazard warning lamps are activated when:

1. The vehicle is locked and the security system is set (flashes three times if superlocked, once if not)
2. The vehicle is unlocked (flashes once for 2 seconds)
3. The alarm is triggered (flashes for the duration of audible warning, 30 seconds)
4. The driver depresses the hazard lamp switch (flashes until the driver presses the switch for a second time)
5. The inertia switch is triggered (flashes until the system is reset) The exact operation of the hazard lamps may alter between different market programmes and customer configuration options.

Security system status LED

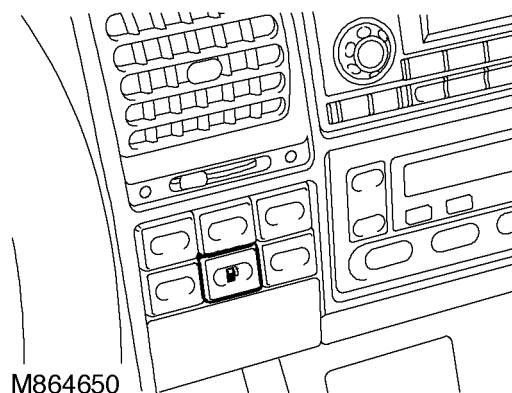
A light emitting diode (LED) situated in the instrument cluster indicates the condition of the security system and acts as a warning to potential thieves that the security system is activated.

Starter relay

The starter relay on both petrol and diesel derivatives is controlled by the BCU. The BCU receives a signal from the ignition switch that the driver wishes the engine to start. If the security system has been deactivated, the BCU will operate the starter relay. The BCU cannot tell if the remobilisation signal has been accepted by the EMS. On occasions where the BCU has received a valid unlock/remobilise signal but the EMS has not, the start relay will energise, causing the engine to crank until it starts. At this point, the starter relay will disengage and the starter motor will stop cranking the engine. The ECM will then immediately stop the engine running. The BCU receives from the instrument pack an engine running signal. If the ignition key is turned to position IV when the BCU is receiving an engine running signal, it will not energise the start motor relay

Fuel flap release switch/actuator

The fuel flap release switch is located within the fascia switch pack (see graphic below). It operates only when the ignition switch is in position 0 or I and the security system is not activated (the state of engine immobilisation has no effect on the operation of the fuel flap switch).



The actuator circuit is inhibited or allowed to operate by the BCU. A voltage from the interior fusebox is provided to the fuel flap release switch. The switch is connected directly to the fuel flap actuator. The actuator is also connected to the BCU. When the necessary conditions have been fulfilled to allow operation of the fuel release flap, the BCU provides a path to ground.

The fuel release flap will operate only if:

1. The ignition is switched 'off'
2. The security system is in a deactivated state
3. The driver presses the fuel flap release switch

Courtesy lamps

The BCU controls the operation of the courtesy lamps. Courtesy lamps are located in the:

1. Front headlining
2. Mid headlining
3. Rear headlining

Headlamps

New Discovery has a feature that allows the BCU to turn on the vehicle headlamps when the driver presses the remote transmitter. The BCU switches both headlamps on by signalling to IDM to switch the headlamp relay 'on'.

System operation

The security system feature is always programmed into the BCU. Depending on the vehicle destination, some of the other security components may not be fitted to the vehicle. In markets that do not need advanced security systems, the remote transmitters will operate the CDL system, but will not activate the alarm features. Engine immobilisation always happens, even if the market programme disables the function. If this is the case, the BCU will transmit the remobilisation code when it detects the ignition change from position II to III.

The security system can be configured in many different ways, according to customer preferences and market legislative demands. The following items are available to all markets and all customer configurations:

1. Locking
2. Unlocking
3. Electric fuel flap release

Locking

The doors can be locked by any one of five methods:

1. Pressing the lock button on the remote transmitter
2. Locking the vehicle from the driver's door with the key
3. Pressing the lower half of the CDL switch

Any of the above actions will lock all of the doors and, in some cases, the security system may also become active.

4. Pushing the sill button down (will only lock that particular door)
5. By travelling over a predetermined speed (if speed related locking is enabled)

The CDL system may not operate correctly if the vehicle is not in a suitable state to become locked. These conditions include:

1. The driver's door is open
2. The ignition is on
3. The inertia fuel cut-off switch is tripped
4. The vehicle is superlocked

Depending on system configuration, a mislock will occur if these conditions are not met. All of the doors may or may not lock, depending on which of the above conditions is not met. If the vehicle is programmed to a market that supports mislock, the vehicle will give an audible warning and will not flash the LED or vehicle hazard lamps, this being the usual indications to the driver that the vehicle has armed the security system successfully.

Unlocking

The doors can be unlocked in any one of five ways:

1. By pressing the unlock button on the remote transmitter
2. By unlocking the vehicle from the driver's door with the key
3. By pressing the upper half of the internal CDL switch (not operational if the vehicle is superlocked)
4. By pulling the interior door handles (not operational if the vehicle is superlocked)
5. By the inertia switch being triggered whilst the ignition is 'on' and the security system deactivated

The BCU may not unlock all of the doors when some of the above actions are completed. The strategy the BCU follows will depend upon the market programme and customer configuration options.

Market dependent security features

The security system (in most markets) has the ability to do most of the following items. The exact operation of each item may vary slightly between different market programmes and customer configurations. The features available are:

- Perimetric protection
- Volumetric protection
- Superlocking
- Mislock
- Passive immobilisation
- Passive remobilisation
- Emergency key access (EKA) code remobilisation
- Single point entry (SPE)
- Speed related locking
- Bathrobe related locking
- Security system LED
- Courtesy lights
- Transit mode

Perimetric protection

Perimetric protection is used to deter unauthorised entry into the vehicle by emitting audible and visual warnings on detection of an intruder. The system detects intrusion by monitoring the state of all hinged panels and the ignition circuit. If the BCU detects a change in state of any of the above it will sound an alarm and give a visual indication (the type of sound and visual indication will depend upon the build specification and some options set by the market programme and customer configuration).

The security system sounder (BBS, alarm horn, or vehicle horn) will sound for thirty seconds on detection of a triggering condition. The BCU will signal the sounder. The security system then resets itself in the condition it was before the security system was triggered.

The perimetric state also enables the engine immobilisation function, if it has not been already set by passive means. To arm the vehicle in a perimetric state, press the lock button on the remote transmitter (the exact operation may vary with different market specification) or lock the vehicle using the key in the driver's door. The following conditions must be met before the BCU will operate all of the functions of perimetric protection.

1. All of the hinged panels in a closed position
2. Ignition key not inserted in ignition switch
3. Inertia switch not tripped

If these conditions are not fulfilled, the BCU will enter a mislock condition. See section on mislock for more details.

To disarm perimetric protection press the remote transmitter's 'unlock' button, or unlock the vehicle with the key in the driver's door (this may alter according to the market specification). If the remote transmitter is needed to remove perimetric protection and is unavailable, the security system can be removed by entering the EKA code.

Volumetric protection

Volumetric protection is a function that the vehicle's security system employs to detect movement within the vehicle's interior. It enhances the perimeter function by detecting situations where personal belongings are threatened by an intruder smashing a window. Volumetric protects by using two ultrasonic sensors to produce a sound 'pressure' inside the vehicle. The sensors monitor the 'tone' of the sound being reflected from interior trim panels and seats etc. If the sensor notes a change in 'tone', it indicates that something is moving within the interior of the vehicle.

New Discovery does not operate both volumetric sensors at the same time. If it did, the sensors would give unreliable detection. As a result, the two sensors within the vehicle interior communicate with each other. Both sensors use the wire used to inform the BCU that it has detected unauthorised movement within the vehicle, as a communication bus, sending a signal to tell the other sensor that it is currently active. When the BCU provides power to both sensors, the first to operate sends a 5mS pulse along the signal wire to indicate that it has activated. After a period of 458mS the first sensor will switch off. The other sensor will, after a delay of 42mS, start to detect movement within the vehicle and also send the 5mS signal to declare that it is active along the signal wire. If one of the sensors detects movement when it is activated, it will provide a path to ground for the signal wire for a period of approximately 500mS. The BCU will interpret this lack of signal and activate the alarm components. The sensors continue to transfer operation between each other until the BCU removes their power.

The two ultrasonic sensors become active after an initial delay of fifteen seconds, providing the vehicle's security system has been set to activate volumetric sensing. This delay is incorporated into the BCU software to prevent spurious triggering events caused by air moving inside the vehicle interior. It is possible to lock the vehicle without arming the volumetric alarm by using the key.

The same three conditions apply when trying to arm the vehicle in volumetric mode. These are:

1. The ignition must not be 'on', and the key must be removed from the ignition lock (market programme dependent)
2. The inertia switch must not be active
3. All of the doors must be closed, as well as both the front windows

To unlock the vehicle and disable the security system, the 'unlock' button on the remote transmitter must be pressed. If certain market configurations are set inside the BCU, it may not be possible to disengage the volumetric protection with the key.

Superlocking

Superlocking prevents the use of the interior door handles to unlock and open the vehicle doors. This prevents an intruder gaining access to the vehicle by smashing a window to open a door.

Pressing the remote transmitter, or turning the key in the door lock activates superlocking. The market specification and customer configuration options will determine if superlocking will activate and how it can be set. There are four options:

1. No superlocking
2. Pressing the lock button on the remote transmitter, or turning the key once
3. Pressing the lock button on the remote transmitter once
4. Pressing the lock button on the remote transmitter, or turning the key twice within 1 second

The vehicle needs to be in the correct 'state' before superlocking will activate. These conditions are:

1. All doors closed
2. Ignition key not inserted in ignition switch
3. Inertia switch not tripped

Mislock function

Mislock alerts the driver to a failed attempt to lock the vehicle. This may be because one or more of the doors, bonnet or tail door is not correctly closed or the key is inserted into the ignition (any position).

A mislock condition will enable security functions only on the parts of the system that the BCU can verify as being reliable (see section on partial arming).

The audible warning of a mislock condition depends on the hardware fitted to the vehicle and on the programmed market. The BCU will trigger the BBS, alarm horn or vehicle horns for 50mS.

The BCU will not flash the hazard lights or operate the LED in a rapid flashing state when it detects a mislock condition. This is true for all market specifications, providing mislock is enabled within the vehicle configuration settings.

Partial arming

Partial arming allows as much of the vehicle to remain protected as possible. If the security system is set with one or more doors open or the bonnet open, the BCU will still monitor the rest of the system.

If the bonnet is open when the security system is armed, the BCU activates superlocking and volumetric sensing. In this condition, the security system enters a partially armed state. All other functions of the security system are active and the BCU monitors the bonnet. If the BCU detects a change in state (from an open state to a closed state), it will arm the security system fully.

If one or more of the doors are open when the vehicle is armed, the BCU will not superlock the remaining doors and will not operate the volumetric sensors. The BCU will continue to monitor the state of all the doors and, if it senses that all doors become closed, it will activate superlocking and volumetric sensing (if previously requested).

Passive immobilisation

Passive immobilisation prevents the vehicle from being started unless a correctly programmed remote transmitter key is used to start the vehicle. This system works whether or not the driver sets the security system into an active state.

The BCU immobilises the engine 5 minutes after the ignition has been switched off, providing the driver's door is not opened. The BCU will immobilise the engine 30 seconds after it detects the driver's door opening.

Immobilisation is achieved by the BCU not transmitting the code to the EMS ECU. This code is needed to allow the engine to continue to run after the initial start-up sequence. If the BCU or ECM is replaced, this code will require synchronisation with the new unit.

Passive remobilisation

The BCU has a function that will automatically remobilise the engine when the ignition is switched 'on', providing the BCU receives a valid code from the remote transmitter. When the ignition is first switched 'on', and the vehicle is in an immobilised state, the BCU powers the passive coil located around the ignition barrel.

The passive coil produces a magnetic field, which excites the circuitry inside the remote transmitter. The transmitter then sends a remobilisation signal to the BCU. If this system fails and the BCU does not receive a valid signal it will stop energising the coil after one minute of operation. The driver of the vehicle will then need to either press the unlock button on the remote transmitter or enter the EKA code to remobilise the engine.

Both engine immobilisation and remobilisation are transparent to the driver of the vehicle providing the system is operating correctly.

Depending upon market configuration and vehicle options, the engine immobilisation features of New Discovery may be allowed to be switched off.

Emergency key access

If the remote transmitter fails to operate, the engine can be remobilised by using the key to enter a unique four digit emergency key access (EKA) code. This procedure is applicable only when the vehicle is programmed with certain market specifications.

The EKA code is entered by turning the ignition key in the driver's door lock. It is similar in operation to the EKA code sequence on pre 1999 MY Discoverys. The process is as follows:

1. Start with all vehicle doors closed and with the ignition key removed from the ignition barrel
2. Turn the ignition key in the door lock to the unlock position and hold it there until the vehicle audibly/visually indicates (there will be no audible indication on vehicles fitted with a BBS sounder) that the EKA sequence has been initiated

The BCU sounds the audible warning in the following sequence:

3. The visual warning consists of the LED being illuminated for 2 seconds
4. Unlock the vehicle the required number of times for the first digit of the code (note, this is the same direction as the step before)
5. Lock the vehicle the required number of times for the second digit
6. Unlock the vehicle the required number of times for the third digit
7. Lock the vehicle the required number of times for the fourth digit
8. Unlock the vehicle one more time to disable the security system

The BCU will signify a successful entry of the EKA code by giving an audible warning.

Whilst entering the code, it is important that the code is entered without leaving more than 10 seconds between any of the key turns or the key is not kept in the lock or unlock position for more than 5 seconds.

At the end of a successful EKA code being entered an internal timer is started. Depending on the market specification currently programmed into the BCU, the vehicle will either disarm immediately, or after 5 minutes. The market programme can also have a condition where the alarm is disarmed but engine immobilisation is still activated for a period of 5 minutes. If the engine is immobilised the security system LED will continue to flash at a rate which is equivalent to that detailed for immobilisation in the earlier section.

The EKA code can be obtained by using TestBook to interrogate the BCU. The BCU will allow the driver 10 incorrect attempts to input the EKA code before it locks out for 10 minutes. If an unsuccessful EKA code is entered, the BCU will sound an audible warning to inform the driver to re-enter the code.

Single point entry

Single point entry is a function that allows the driver to unlock just the driver's door, thus leaving all the other doors in a locked state. It is an option that can be set, if required, by TestBook. Most market configurations do not have SPE set as their default.

To use single point entry, press the 'unlock' button on the remote transmitter once. Depressing the unlock button a second time in the space of one minute unlocks the remaining doors. Single point entry is also possible by turning the key in the driver's door lock to the 'unlock' position, once. Turning the key to the 'unlock' position again within one minute unlocks the remaining doors. It is also possible to use a combination of key and remote transmitter unlock signals to unlock all of the doors.

Speed related locking

As an added option, New Discovery features speed related locking. This feature locks all the doors automatically when the vehicle speed exceeds 7 km/h (4 m.p.h.). The speed related locking function can be disabled within the customer configuration options available within the BCU. It is not set as a default setting from the factory, so the dealer will need to set it if the customer prefers his/her vehicle to behave in this manner.

The vehicle will unlock automatically when the ignition is switched off, providing the vehicle has been locked by the speed related locking function. Speed related locking only locks the vehicle once every journey/ignition cycle. If the doors are unlocked after the vehicle speed has exceeded 7 Km/h (4 m.p.h.), the vehicle will not lock under speed related locking until the ignition has been switched 'off' and then back 'on' again.

If the unlock button on the fascia (CDL switch) is pressed it will disable the operation of speed related locking for the duration of the journey.

Bathrobe locking

Bathrobe locking allows the engine to be started and then the vehicle locked with a spare key. This allows the vehicle interior to reach the desired temperature without the driver needing to be present. This option can be set by TestBook within the customer configuration options inside BCU. It should be noted that the vehicle security system is not set during this procedure, only the CDL is activated.

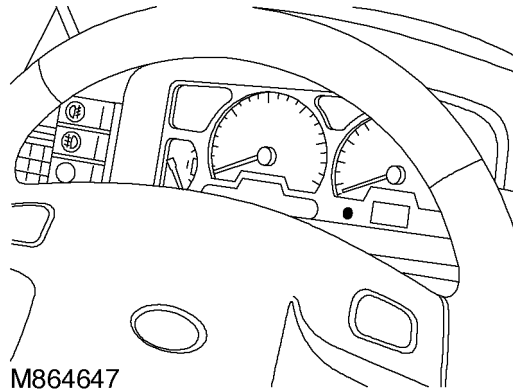
Courtesy headlamps

An option within the configuration of the BCU allows for courtesy headlamps to be enabled or disabled. This feature activates the headlamps for 30 seconds when the lock button on the remote transmitter is held down for longer than 1 second. The headlamps will extinguish if the BCU receives either a lock or unlock signal from the remote transmitter.

Security system LED

The LED has four different flash rates. These flash rates signal to the driver the different modes of operation or other system information. The four flash rates are:

1. Flash for 10 seconds at a rate of 10 Hz (50mS 'on', 50mS 'off')
2. Flash at a rate of 10 Hz (50mS 'on', 50mS 'off')
3. Flash until the system changes state at a rate of 50mS 'on', 2000mS 'off'
4. Flash 'on' for 50mS, 'off' for 50mS, 'on' for 50mS and 'off' for 2000mS



When the driver first locks the vehicle with either the key or the remote transmitter (assuming the vehicle does not mislock), the LED will follow flash rate 1 (indicating the correct setting of the security system). After 10 seconds the system will follow flash rate 3 (indication of security system being set). If the engine is immobilised but the alarm system is not set, the LED will signal the driver by following flash rate 3 (indicating the security system is set. If the vehicle is immobilised and the ignition is switch to position II, the LED will illuminate (to indicate that the engine will not start). It will extinguish only when the BCU receives a valid remobilise signal, or the ignition is switched to position 0 or I. If the alarm has triggered since the BCU received a valid 'arm' signal, the LED will follow flash rate 2. When the BCU receives an unlock signal (this indicates that the security system has being activated), the LED will follow flash rate 2 until the ignition is next turned to position II. The LED will flash one longer period if the EKA code sequence is stated.

The BCU will alert the driver of the vehicle if the remote transmitter battery requires replacing. The remote transmitter measures its battery voltage, and when the voltage goes below a threshold it will transmit a special code to the BCU to request that it informs the driver by flashing the LED at the rate detailed in rate 4. This is conditional upon the driver's door being open and the ignition in an 'off' position, or the key removed from the ignition barrel.

Courtesy lights

The courtesy lights operate at full brightness when first switched on. The BCU will dim the brightness before it switches them off (fade-out). Fade-out always happens over a period of 2 seconds and always follows the decision to turn off the lights.

The following table details for how long the courtesy lights will operate after the BCU detects a condition that will illuminate them.

Operation	Condition	Time
Door open10		10 minutes
Unlock signal from the remote transmitter	All doors closed & key not in position III	1 minute
Unlock signal from the driver's door lock	All doors closed & key not in position III	1 minute
Ignition key turned from position II or III to position O	All doors closed	1 minute
Door changing from open to closed	All other doors closed & ignition not in position III	15 seconds
Ignition position III		Timer cancelled
BCU receives a lock command		Timer cancelled
Vehicle has transit mode configured to 'on'		15 seconds on all occasions

Transit mode

To prevent excessive battery drain during transportation of the vehicle after leaving the factory, a transit mode function has been introduced. This mode disables the following functions/systems:

1. Volumetric sensors
2. Passive immobilisation (will remobilise the engine on a valid unlock signal from the driver's door lock, regardless of the programmed market)
3. Immobilisation of the vehicle by use of the door lock inputs
4. Ignition key interlock
5. Electric seat enable time-out with driver's door open

When TestBook communicates with the BCU for any diagnostic related to BCU diagnostics, it checks that the vehicle is not in transit mode. If it is, TestBook prompts the operator to remove the vehicle from transit mode before s/he continues. The vehicle can also be removed from transit mode by simultaneously holding down the heated rear window and the rear fog lamp switches and turning the ignition switch from position 0 to position III for 2 seconds

In car entertainment

The New Discovery model range features several different in car entertainment (ICE) system options. The exact specification of the equipment fitted to any particular vehicle is dependent upon its trim level and the regional requirements of its destination market. In all cases, the ICE system will comprise a head unit (fascia mounted control unit), speakers and antenna. Depending upon the exact specification and configuration of the vehicle, the system may also incorporate a remote control unit, a power amplifier and a CD autochanger. There are four standard ICE system configurations available:

1. Standard configuration (trim level 1)
 - a. Philips head unit (radio-cassette unit)
 - b. Harman 152mm (6") 30W 'full range' door speakers (one in each door, excluding the tail door)
 - c. Single FM/AM antenna (mounted on right-hand rear side window)
2. EX, Fxi and FxiS specification (trim levels 2 and 3)
 - a. Philips head unit (radio-cassette and CD-ready unit)
 - b. Harman 152mm (6") 30W base and mid-range door speakers (one speaker in each door, excluding the tail door)
 - c. Harman 25mm (1") 30W tweeter speakers located in the 'A' post finishers
 - d. Steering wheel remote control unit
 - e. Single FM/AM antenna (mounted on right-hand rear side window)
3. SD and SE (trim levels 2 and 3 NAS and Japanese specification)
 - a. Alpine head unit (radio-cassette and CD-ready unit)
 - b. Harman 152mm (6") 30W base and mid-range door speakers (one speaker in each door, excluding the tail door)
 - c. Harman 25mm (1") 30W tweeter speakers located in the 'A' post trim finishers
 - d. Steering wheel remote control unit
 - e. Single FM/AM antenna (mounted on right-hand rear side window)
4. ES, FxiXS and LSE (trim level 4)
 - a. Alpine head unit (radio-cassette and CD-ready unit)
 - b. Alpine 6 CD autochanger unit (located under the right hand front seat)
 - c. Harman power amplifier 330W RMS at 1% distortion
 - d. Harman 152mm (6") 40W base and Harman 152mm (6") 40W mid-range door speakers (two speakers in each front door, and one speaker in each rear door)
 - e. Two tail door mounted 40W extended-throw sub-woofer speakers
 - f. Two Harman 33mm (1¹/₄") 40W tweeter speakers located in the 'A' post finishers and two 33mm (1¹/₄") tweeters mounted in the rear passenger door casings
 - g. One FM/AM antenna (mounted on right-hand rear side window) and one FM antenna (mounted on left-hand rear side window)
 - h. Rear headphone modules
 - i. Steering wheel remote control unit

New features

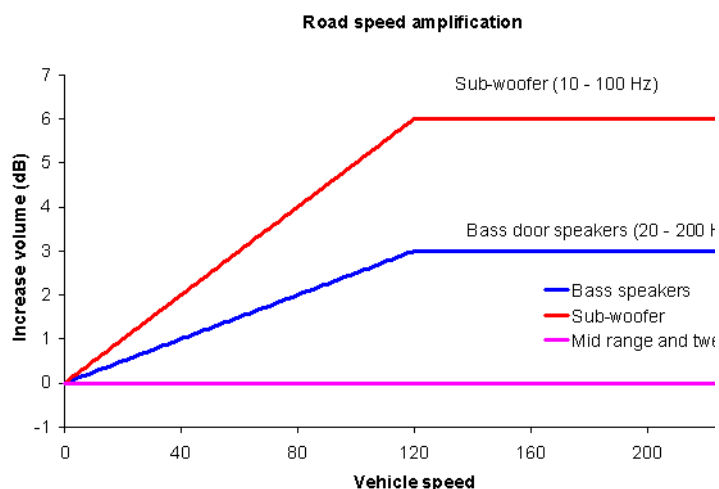
The premium ICE system fitted to New Discovery brings many new features to the 4x4 Market. A summarised description of the functionality of a selected number of these new features is given below. This information is provided to develop the reader's basic understanding of the improvements and interconnection details. Full details of the functionality of all the ICE system components and features can be found in the owners handbook provided with the vehicle.

Audio power amplifier

The power amplifier is situated underneath the left-hand seat. Its location does not change whatever the configuration of the steering. The power amplifier provides an audio signal to each of the speakers via 'twisted pair' wires. These wires reduce the effect of other electrical systems on the sound quality of the audio system. The remote amplifier also powers the sub-woofers directly, so there is no rear amplifier within this system.

The amplifier receives an 'enable' signal from the head unit. This enable signal switches the power amplifier on, but does not provide the power feed for the unit. The amplifier receives separate audio signals from the head unit for each of the speakers incorporated into the system.

Speed related volume



A road speed input signal is supplied to the amplifier from the SLABS ECU. In response to this input, the amplifier automatically adjusts the audio signal balance boosting the lower frequency notes to overcome road to tyre noise. This capability ensures the perceived volume of sound remains at a constant level, regardless of the predictable changes in background noise caused by increases and decreases in vehicle speed.

ICE amplifier



Rear headphone modules

Two rear headphone modules are incorporated into the premium ICE system. The modules are located just behind the rear seats, one on each side of the vehicle. The modules enable the rear passengers to select an audio source (i.e. tape, radio or CD), independently of the source being used by the vehicle system. The ICE system is capable of supporting independent operation of any two of the three audio sources simultaneously. An audio signal is supplied to the rear headphone modules from the head unit only if the headphones are plugged in (see graphic below). Once plugged in, the audio source and volume can be set as desired. The two rear headphone modules do not operate independently of one another, except for the ability to adjust the volume of sound delivered to the headphone. Consequently, it is not possible to select a different audio source or to select a function controlling the audio source, e.g. fast forward, track skip, etc., without affecting the supply to the other module.

Rear headphone module



The operation and illumination of the rear modules is dependent upon the specific operating conditions, described below:

1. If the head unit is switched off, then the rear modules will not be active and will not be illuminated
2. If the head unit is switched on but the headphone jack plug is not inserted, the headphone sockets will be illuminated
3. Upon the headphone jack plug being inserted into one of the rear headphone modules, the head unit will:
 - Reduce the bass volume of the audio signal
 - Switch off the sub-woofer
 - Illuminate the headphone icon on the radio display
 - Illuminate the source icon for the rear headphone (next to the 'headphone in' icon on the head unit display)
 - Illuminate all the buttons of the rear headphone modules

It is not possible to override the driver's wishes using the controls on the rear modules. This remains the case even if the driver changes to the option currently being used by the rear headphone modules.

Each of the modules incorporates an internal amplifier. The amplifiers enable the head unit to supply a single audio source to both modules. The head unit also supplies an 'enable' signal to the rear modules in the same manner as it supplies an enable signal to the main amplifier.

Premium head unit

The premium head unit is manufactured and supplied by Alpine (Audio Co). Many of the function/modes featured on the unit are similar to those available on other ICE systems previously used on Land Rover products. There are, however, several new functions available to the driver. These are:

1. A “dot matrix” display. The ‘dot matrix’ display provides an improvement over the usual LCD display in respect of brightness and clarity of symbols. Using this type of display, it is possible to display information in both numeric and more realistic alpha formats
2. The unit features a ‘spatial’ sound configuration. This feature provides the driver with a predetermined sound balance suited to the vehicle. This combination of sound balance, audio signal phase shifting and bass and treble amplification has been specially developed for New Discovery and is designed to increase the ‘depth’ and ‘character’ of sound
3. The system incorporates an optional third-party mobile phone installer. This utilises one of the terminal connections on the back of the head unit. This facility will automatically ‘mute’ the audio output for the duration of the phone call
4. The head unit is connected to two antennas. It uses the signal supplied by the right-hand antenna only for all non-FM radio stations. It monitors the signal supplied by both antennas and selects the best signal for all FM radio stations