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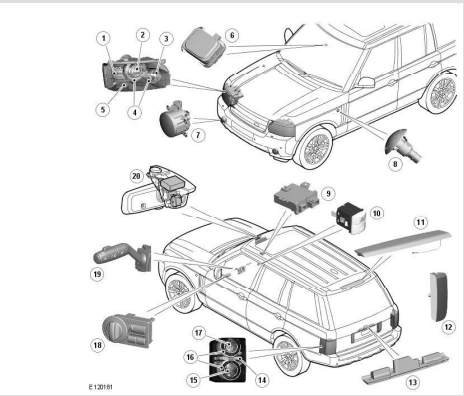
EXTERIOR LIGHTING (G1194093)

EXTERIOR LIGHTING COMPONENT LOCATION



ITEM	DESCRIPTION
1	Front turn signal indicator LED's
2	High/low beam headlamp
3	High beam (fill in) lamp
4	Side lamps light emitting diode (LED)'s
5	Static bending/cornering lamp (if fitted)
6	Rain/light sensor
7	Front fog lamp
8	Turn signal indicator side repeater
9	Adaptive Front lighting System (AFS) control module (if fitted)
10	Hazard warning lamp switch
11	High mounted stop lamp
12	Reversing lamps
13	License plate lamps
14	Turn signal indicator
15	Fog lamp
16	Tail lamps
17	Stop lamp

ITEM	DESCRIPTION
18	Lighting control switch
19	Left hand steering column multifunction switch
20	Auto High Beam control module (inside mirror body)

OVERVIEW

The exterior lighting is controlled by the Central Junction Box (CJB). The CJB controls the following vehicle functions:

- Control and monitoring of exterior lamps including turn signal indicators and hazard warning functionality
- Illumination dimmer control of instrument cluster and all interior switch illumination
- Communication and control and monitoring of trailer lighting via the trailer module
- Monitoring and evaluation of check control inputs from other system control modules and output of applicable messages in the instrument cluster message center.

The CJB is connected to the medium speed Controller Area Network (CAN) bus and communicates with other vehicle systems via the instrument cluster. The CJB contains a microprocessor which performs the control, monitoring and evaluation functions.

A combined rain/light sensor is fitted which controls the automatic wiper operation and the automatic lighting function.

An Auto High Beam system can also be fitted which automatically controls the high beam headlamps.

The exterior lighting system comprises the following exterior lamps:

- Front and rear side lamps
- License plate lamps
- Side marker lamps (if fitted)
- Front and rear turn signal indicator lamps
- Turn signal indicators side repeater lamps
- Stop lamps and high mounted stop lamp
- Reversing lamps
- Rear fog lamps
- Front fog lamps
- Static bending lamps (if fitted - AFS headlamp except NAS)
- Low and high beam headlamps
- Adaptive Front lighting System (AFS) (if fitted).

EXTERIOR LAMP BULBS

The following table shows the bulbs used for the exterior lighting system and their type and specification.

Exterior Lamps Bulb Type/Rating Table

BULB	TYPE	RATING
Bi-Xenon™ headlamps - Low/High beam	Xenon D3S	35W
Headlamps - High beam 'fill-in'	Halogen H7 LL	55W
Static bending lamp (all except NAS)	2 LED's (high output)	-
Front fog lamps	Halogen H11	-
Rear fog lamps	3 LED's (high output)	-
Turn signal indicators - Front	12 LED's	-
Turn signal indicators - Rear	12 LED's	-
Turn signal indicator side repeaters	Capless WY5W	5W
Stop lamps	19 LED's	-
Tail lamps	21 LED's	-
High mounted stop lamp	20 LED's	-
License plate lamps	Festoon	5W
Reversing lamps	Bayonet H6W	6W
NAS - Side marker lamp (front/rear)	1 LED	-
Front side lamps	14 LED's	-

The bulbs and the Light Emitting Diode (LED)'s are driven by Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) within the Central Electronics Module (CEM) which is an integral component of the CJB. An exception to this is the rear tail lamps, front fog lamps and reverse lamps which are supplied with power via relays within the CJB and are protected by conventional fuses.

CENTRAL JUNCTION BOX

The CJB is located behind the glove compartment and is connected to the vehicle wiring harness with 8 multiplugs.

The CJB receives four permanent battery power supplies via the Battery Junction Box (BJB).

The lighting circuits are not all protected by conventional fuses as some are protected by Metal Oxide Semiconductor Field Effect Transistors (MOSFETs). The control circuitry within the CJB and the CJB for each individual circuit can detect and isolate a problem circuit.

Failure of a lamp is not notified to the driver. If a turn signal indicator fails the turn signal warning indicator in the instrument cluster will flash at double speed.

INPUT SIGNALS FOR LAMP CONTROL

The CJB receives inputs from the following switches:

- Lighting control switch for side lamps, headlamps and auto headlamps
- Momentary push switches for front and rear fog lamps
- Left hand steering column multifunction switch for turn signal indicators and high beam/headlamp flash and Auto High Beam system
- Brake pedal switch
- Momentary push switch for hazard warning.

The switches are supplied with a 10mA supply from the CJB and switch to ground when operated. The CJB detects that a switch has been operated (ON) when its closing resistance is less than 100 Ohm and is detected as OFF when its resistance is more than 10K Ohm.

The lighting control switch uses a binary system which is detected by the CJB which determines the selected position. The output from the lighting control switch is shown in the following table:

SWITCH STATE	SWITCH 1	SWITCH 2
Off	1	1
Side lamps	1	0
Headlamps	0	0
Auto headlamps	0	1

The CJB also receives ignition status via hard wired connections from the stop/start switch.

A reverse gear engaged signal is also received on the high speed CAN bus from the Transmission Control Module (TCM) to enable the CJB to activate the reverse lamps.

The CJB can receive a hazard warning indicator activation message from the Restraints Control Module (RCM), via the high speed CAN bus, in the event of a crash. The CJB can also activate the hazard warning indicators to signify vehicle locking to the driver.

On vehicles with Auto High Beam, the auto high beam control module outputs signals on the medium speed CAN bus to the CJB to control the high beam headlamps.

CIRCUIT PROTECTION

Operation of the lamps is performed using overload proof Metal Oxide Semiconductor Field Effect Transistors (MOSFETs). The MOSFETs can detect overload, load interruption with the lamps switched on and short circuit to positive with the lamps switched off.

The MOSFETs are protected against short circuits, removing the requirement for the lamps circuits to be protected by fuses. The MOSFETs respond to heat generated by increased current flow caused by a short circuit. Normally this would cause the fuse to blow. The MOSFETs react to the heat increase and cut the supply to the affected circuit. Once the fault has been rectified or the MOSFET has cooled, the MOSFET will automatically reset and operate the circuit normally.

If an overload occurs, the current flow is dependant on the temperature of the related MOSFET and can be up to 20 times the rated current of the lamp. The MOSFET heats up and deactivates the load applied to the circuit. When the MOSFET cools the circuit is once again reactivated. This thermal cycling occurs continuously in the event of an overload occurring.

A number of lamps are controlled by relays and these circuits are protected by conventional fuses.

BULB MONITORING

Bulb failure monitoring is performed by the CJB processor. The lamps are cold and warm monitored by the MOSFETs in order to detect bulb failure.

NOTE:

Relay controlled lamps have no diagnostic monitoring.

The CJB processor provides outputs to each MOSFET. The output switches the MOSFET to supply the required output to power the applicable lighting circuit. The microprocessor evaluates the circuits by detecting the returned signals from the controlling MOSFET.

When the bulb or LED is functioning normally, the output signal voltage from the controlling MOSFET is 0V. If a bulb or LED in the circuit fails, an open circuit occurs and the MOSFET outputs a signal of 5V to the processor. The signal is interpreted as a bulb or LED failure and generates a Diagnostic Trouble Code (DTC) which can be retrieved using an approved Land Rover diagnostic system.

Warm monitoring is performed continuously when the lights are switched on by evaluating the diagnostic output of the MOSFET switches. Cold monitoring is performed at 32 second intervals when the lights are switched off. The MOSFETs briefly switch on the lights for approximately 1 millisecond (this is insufficient to illuminate the bulb or LED) and checks the bulb or LED as per warm monitoring.

Cold monitoring is not possible for the low/high beam headlamps of vehicles using xenon bulbs. On these vehicles the cold monitoring of the low/high beam headlamps is switched off in the CJB. The CJB detects a failed xenon bulb via a reduction in current flow to the affected headlamp's xenon control module.

When a xenon bulb fails, the control module's current consumption falls to 60mA, which the CJB detects as unsuccessful bulb illumination.

ALARM INDICATIONS

The CJB can also display alarm visual indications for alarm arm, disarm and triggered conditions.

If the hazard warning lamps are active when a lock or unlock request is made, the hazard warning cycle is interrupted to allow the visual indication of the requested lock cycle. When visual indication is completed, the hazard warning operation will continue.

If the vehicle is involved in crash of a severity for the RCM to initiate deployment of the airbags, the control module outputs a hazard warning lamps on request on the medium speed CAN bus to the CJB. The hazard warning lamps will be activated and will continue until the RCM outputs a message to deactivate the hazard warning lamps.

REDUNDANT DATA STORAGE

The CJB stores data relating to the Vehicle Identification Number (VIN), total mileage and service interval indicator. This data is received by the CJB from the instrument cluster and used as a back-up in the event of instrument cluster replacement.

If the CJB is to be replaced, an approved Land Rover diagnostic system must be connected to the vehicle and the CJB replacement procedure followed to ensure that the stored data is transferred to the new unit.

LOW VOLTAGE OPERATION

If the battery voltage falls below 11.2V, the CJB operates the minimum lighting to preserve the remaining battery charge.

CRASH SIGNAL ACTIVATION

In the event of an accident of a severity to activate and deploy the airbags, the Restraints Control Module (RCM) requests various electrical operations to assist with the crash situation. The RCM requests via the bus systems to the CJB to activate the hazard warning lamps.

SECURITY SYSTEM ACTIVATION

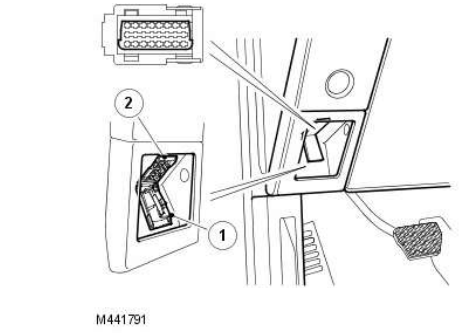
In the event of the security system being triggered, the CJB requests activation of the hazard warning lamps.

INSTRUMENT PANEL AND SWITCH ILLUMINATION DIMMING

The CJB controls the instrument cluster backlighting illumination and also illumination of all instrument panel switches.

The CJB supplies a power output to all switch illumination bulbs at a voltage determined by the position of the manual dimmer rheostat. The switch illumination is activated when the lighting control switch is in the side lamp or headlamp position.

DIAGNOSTICS

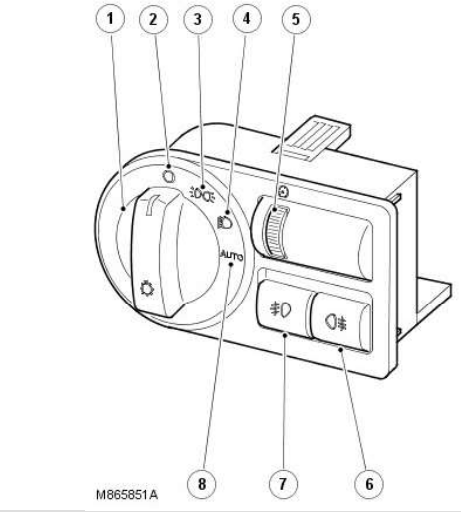


ITEM	DESCRIPTION
1	Cover
2	Diagnostic socket

The diagnostic socket allows for the transfer of information between the CJB and the approved Land Rover diagnostic system. The diagnostic socket is located in the lower instrument panel, above the pedals. The socket is secured in the instrument panel and protected by a hinged cover.

The CJB has diagnostic capabilities and stores fault codes relating to the lighting systems. The xenon control modules cannot be interrogated via the CJB.

LIGHTING CONTROL SWITCH



ITEM	DESCRIPTION
1	Lighting control rotary switch
2	Off position
3	Side lamps position
4	Headlamps position
5	Instrument illumination dimmer rheostat
6	Rear fog lamp switch
7	Front fog lamp switch
8	Auto position

The lighting control switch is located in the instrument panel between the steering column and the driver's door. The switch comprises a four position rotary switch for controlling side lamps and headlamps, a thumbwheel rheostat which manually controls the instrument panel and interior switch night illumination, and momentary push switches for front and rear fog lamps.

The rotary side and headlamp control switch has 2 connections to the CJB. These 2 connections supply a hardwired binary code to the CJB which correspond to the switch position selection made.

The front and rear fog lamp switches operate by completing earth paths for a reference voltage from the CJB when the switch is pressed. The fog lamp switches are momentary, non-latching switches which briefly complete an earth path which is sensed by the CJB.

LIGHTING CONTROL SWITCH ILLUMINATION

When the stop/start switch is pressed to activate the accessory or ignition power modes, the switch legends on the lighting control switch are illuminated at maximum brightness when the lighting control switch is in the 'O' (off) position. When the lighting control switch is rotated to the side, headlamp or AUTO position the legend illumination is dimmed.

HEADLAMP ASSEMBLY

GENERAL

Two types of headlamp are available; Bi-xenon™ or Adaptive Front lighting System (AFS).

The headlamps are located on the bonnet locking platform. Each headlamp is secured at the top to the bonnet locking platform with 1 screw, 1 screw at the bottom to the front bumper support bracket, 1 screw on the fender edge bracket and 1 screw on the headlamp mounting panel. Headlamp removal is facilitated by removal of the radiator grille, front bumper and removal of the 4 headlamp attachment screws.

Headlamp removal is not required for replacement of the xenon or halogen bulbs. The rear of the headlamp unit has removable access covers which allow access to the bulbs and tourist lever.

A large cover, which is rotated counter-clockwise to remove, allows access to the low/high beam xenon bulb.

A second cover, on the inboard side of the headlamp, can be removed to allow access to the high beam 'fill-in' lamp halogen bulb. The bulb is mounted in a holder with an extended end to aid removal.

The turn signal indicators, side lamps, static bending lamp (where fitted) and the side marker lamp (where fitted) are LED's. None of the LED's are serviceable items.

In all markets except NAS, the headlamps have two adjustment screws which allow for the manual setting of the vertical and horizontal beam alignment. A 6mm Allen key is used to rotate the adjusters to achieve the required setting. The inboard adjuster controls the vertical aiming and the outboard adjuster controls the horizontal aiming.

On NAS vehicles the headlamp is regarded as 'Visual Optically Left' (VOL) aiming. There is no horizontal adjustment. Refer to the Service Repair Procedures manual for headlamp alignment data and procedures.

Each headlamp has an integral sixteen pin connector which provides inputs and outputs for the various functions of the headlamp assembly. The usage of the pins differs between model variants. Refer to the Electrical Library and circuit diagrams for pin details.

Two breathers are located on the rear of the headlamp housing. The Goretex breathers allow air flow in and out of the headlamp but prevent the ingress of moisture from rain, road spray or washing. If condensation occurs within the headlamp, check that the breathers are not blocked with mud etc before further action is taken.

HEADLAMP OPERATION

The lamps contained within the headlamp assembly have differing functionality depending on the function selected.

The low beam headlamps are switched on when the ignition is in power mode 6 (ignition on) and:

- the lighting control switch is the headlamp position or
- the lighting control switch is in the 'AUTO' position and a 'lights on' signal is received by the CJB from the rain/light sensor.

The low beam headlamps can also be operated by the headlamp delay feature.

The high beam headlamps are switched on when the ignition is in power mode 6 (ignition on) and:

- the lighting control switch is in the headlamp position or the headlamps are activated by the AUTO feature and the left hand steering column multifunction switch is pushed forward, away from the driver or
- the headlamp flash function is operated by pulling the left hand steering column multifunction switch towards the driver or
- the auto high beam system is active.

COMMON HEADLAMP FEATURES

Turn Signal Indicators

The turn signal indicator LED's are located in 3 rows of 4 LED's in the outer part of the headlamp assembly. The LED's are not serviceable components. The LED's are controlled by an LED control module located at the rear of the headlamp assembly.

Side Lamps

The side lamp LED's are located in a circular pattern around the circumference of the both the xenon projector module (8 LED's) and the halogen high beam fill-in lamp (6 LED's). The LED's are not serviceable components. The LED's are controlled an LED control module located at the rear of the headlamp assembly.

Side Marker Lamps (NAS only)

The side marker lamp LED is located in a molded receptacle in the outer edge of the headlamp. The side marker lamp illuminates a small rectangular section between the orange side reflectors on the outside of the headlamp. The LED is not a serviceable component.

Tourist Lever

A tourist lever mechanism is located on the side of the xenon projector module. This mechanism moves a flap to blank off a portion of the beam spread to enable the vehicle to be driven in opposite drive hand markets without applying blanking decals to the headlamp lens.

The position of the tourist lever varies between headlamp variants and drive hand markets. The following lists detail the lever location and positions for home and opposite drive hand markets.

For RH side headlamps, the tourist function is operated by pushing up the lever. The delivery condition is with the tourist lever pushed down. For left-hand (LH) side headlamps , the tourist function is operated by pushing the lever down. The delivery condition is with the tourist lever pushed up.

Bi-Xenon™ / AFS Headlamps

- UK Left Hand (LH) side headlamp: tourist lever on the fender side
- UK Right Hand (RH) side headlamp: tourist lever on the grille side
- ROW LH side headlamp: tourist lever on the grille side
- ROW RH side headlamp: tourist lever on the fender side

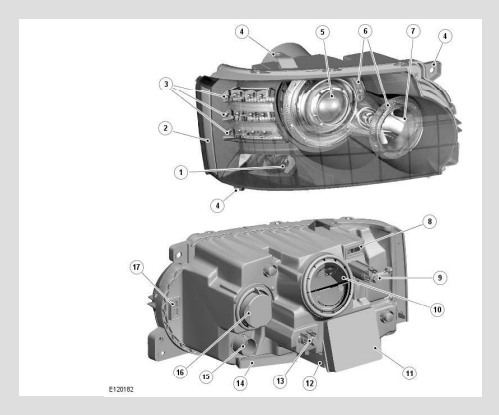
For all xenon and AFS headlamp variants the tourist function is operated by pushing the lever down. The delivery condition is with the tourist lever pushed up.

STATIC HEADLAMP LEVELING – XENON HEADLAMPS

Static vehicle headlamp leveling is performed by the air suspension system and the air suspension control module. The suspension system constantly monitors the vehicle attitude and adjusts the height of the front and/or rear of the vehicle accordingly. This maintains the correct vehicle attitude and consequently maintains the correct headlamp beam alignment.

The vehicle leveling system is fully automatic, therefore the lighting control switch does not have a manual leveling rotary control.

XENON HEADLAMPS



ITEM	DESCRIPTION
1	Static bending / cornering lamp LED's (where fitted)
2	Side marker lamp (NAS only)
3	Turn signal indicator LED's (12 off)
4	Headlamp mounting locations
5	Bi-xenon™ projector module
6	Side lamp LED's (14 off)
7	High beam halogen 'fill-in' lamp
8	Breather (2 off)
9	Horizontal beam adjuster
10	Cover - bi-xenon™ headlamp bulb and tourist lever
11	LED control module - side lamps and side marker lamp (NAS only)
12	Xenon control module
13	Vertical beam adjuster
14	LED control module - turn signal indicator and static bending lamp (if fitted)

ITEM	DESCRIPTION
15	Electrical connector
16	Cover - high beam 'fill-in' lamp

Safety Precautions

WARNING:

The Xenon system generates up to 28000 volts and contact with this voltage could lead to fatality. Make sure that the headlamps are switched off before working on the system.

The following safety precautions must be followed when working on the xenon headlamp system:

- **DO NOT** attempt any procedures on the xenon headlamps when the lights are switched on
- Handling of the D3S xenon bulb must be performed using suitable protective equipment, e.g. gloves and goggles. The glass part of the bulb must not be touched
- Xenon bulbs must be disposed of as hazardous waste
- Only operate the lamp in a mounted condition in the reflector.

The headlamps use a complex surface reflector for the halogen high beam 'fill-in' lamp. This type of lamp has the reflector divided into separate parabolic segments, with each segment having a different focal length. A halogen H7LL 55W bulb is retained in an extended holder. The holder is secured in the rear of the high beam 'fill-in' lamp lens by rotating clockwise.

The xenon headlamp is known as 'Bi-Xenon™' (the Bi-Xenon™ trademark is the property of Hella KGaA Hueck & Co., Germany) because it operates as both a low and high beam unit. The xenon bulb is located in a projector module which comprises an ellipsoidal lens with a solenoid controlled shutter to change the beam output from low to high.

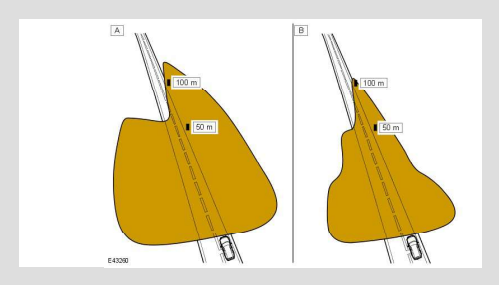
NOTE:

If the lighting control switch is in the 0 (off) position, the xenon lamps do not operate when the high beam 'flash' function is operated. If the lighting switch is in the headlamp position or the 'AUTO' position with the low beam headlamp active, the xenon low beam will remain on when the high beam 'flash' function is operated.

The xenon headlamp system is controlled by the CJB using a xenon control module and an igniter for each headlamp. The xenon control modules and the igniters provide the regulated power supply required to illuminate the xenon bulbs through their start-up phases of operation.

The xenon bulb is located in the rear of the projector module. The D3S xenon bulb incorporates an integral igniter unit and both components must be replaced if the bulb fails.

Xenon/Halogen Headlamp Beam Comparison



ITEM	DESCRIPTION
A	Bi-Xenon™
B	Halogen

The xenon headlamp is a self contained unit located within the headlamp assembly. The unit comprises a reflector, an adaptor ring, the lens, a shutter controller and the xenon bulb, which as an assembly is known as the projector module.

The reflector is curved and provides the mounting for the xenon bulb. The bulb locates in a keyway to ensure correct alignment in the reflector. The bulb is an integral part of the igniter and is electrically connected by a connector located in the igniter unit.

The shutter controller is a solenoid which operates the shutter mechanism via a lever. The shutter is used to change the beam projection from low beam to high beam and visa versa.

The xenon bulbs illuminate when an arc of electrical current is established between two electrodes within the bulb. The xenon gas sealed in the bulb reacts to the electrical excitation and the heat generated by the current flow to produce the characteristic blue/white light.

To operate at full efficiency, the xenon bulb goes through three stages of operation before full output for continuous operation is achieved. The three phases are; start-up phase, warm-up phase and continuous phase.

In the start-up phase, the bulb requires an initial high voltage starting pulse of up to 30000 volts to establish the arc. This is produced by the igniter. The warm-up phase begins once the arc is established. The xenon control module regulates the supply to the bulb to 2.6A which gives a lamp output of 75W. During this phase, the xenon gas begins to illuminate brightly and the environment within the bulb stabilizes ensuring a continual current flow between the electrodes. When the warm-up phase is complete, the xenon control module changes to continuous phase. The supply voltage to the bulb is reduced and the operating power required for continual operation is reduced to 35W. The process from start-up to continuous phase is completed in a very short time.

The xenon system is controlled by the CJB, the two xenon control modules and the two igniters. The xenon control modules (one per headlamp) receive an operating voltage from the CJB when the headlamps are switched on. The modules regulate the power supply required through the phases of start-up.

The igniters (one per headlamp) generate the initial high voltage required to establish the arc. The igniters have integral coils which generate high voltage pulses required for start-up. Once the xenon bulbs are operating, the igniters provide a closed circuit for regulated power supply from the control modules.

ADAPTIVE FRONT LIGHTING SYSTEM (AFS) HEADLAMPS

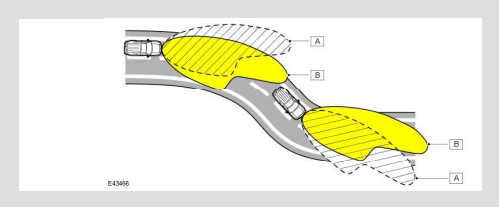
The AFS headlamp is similar in its construction to the xenon headlamp described previously. The projector module is constructed and operates as described for the xenon headlamp with the addition of the AFS system which allows the projector module to be moved vertically and horizontally by stepper motors. The following description covers the additional differences to the xenon headlamp with AFS.

The AFS is a system to improve driver visibility under differing driving conditions. AFS provides a larger visible area which is illuminated when cornering by adjusting the position of the beam distribution on the road. Horizontal adjustment is made automatically to the most suitable orientation for the driving conditions using steering angle and information from other vehicle sensors.

AFS includes the dynamic headlamp leveling system described in the 'Headlamp Leveling' section of this document. The bi-xenon™ module within the headlamp is controlled by actuator motors which rotate the projector module on its vertical and horizontal axes to adjust the beam output to suit the cornering conditions and vehicle inclination. Only the bi-xenon™ lamp projector module swivels, the halogen high beam lamp unit remains static.

The AFS is controlled by an AFS control module which is located on the instrument panel frame, behind the glove compartment. The module is connected to and controls an AFS power module located inside the headlamp housing. Signals from the AFS control module are processed by the AFS power module which powers stepper motors to adjust the vertical and horizontal alignment of the projector module. The AFS power module also controls and regulates the operation of the static bending lamp (if fitted) which is requested by the AFS control module but controlled by the CJB.

AFS Concept



ITEM	DESCRIPTION
A	Conventional headlamp beam distribution
B	AFS headlamp beam distribution

The AFS xenon headlamp construction is similar to the non-AFS xenon headlamp assembly. The AFS headlamp has a xenon control module located on the underside of the lamp assembly. An additional AFS power module is located inside the headlamp housing. The AFS power modules supply the correct voltage to the stepper motors which control the positioning and movement of the AFS projector module.

The AFS assembly contains an additional carrier frame which provides the location for the AFS actuators. The remaining lamps are as described previously for the xenon headlamp. The AFS headlamp also incorporates a static bending/cornering lamp (except on NAS market vehicles).

The carrier frame is attached to the AFS vertical actuator. The projector module has a central pivot point which allows the module to move horizontally in response to operation of the AFS horizontal actuator.

The AFS actuators are bi-polar (2 phase) dc stepper motors which are driven by a power output from the AFS power module. Each stepper motor receives its position information from the AFS control module via the applicable AFS power module. When the actuators are powered to their requested positions, a holding current is applied to maintain the actuator position.

The actuators do not supply a positional feedback signal to the AFS control module. Each stepper motor requires referencing each time the AFS system becomes active. When the AFS system is active, each vertical actuator is driven in the low beam position and each horizontal actuator is driven to an inboard position until a mechanical stop in the actuator is reached. Once the stop is reached a step counter in the AFS control module is set to zero and the actuator is then powered to the operating position as determined by the AFS control module software.

The AFS control module receives front and rear suspension height data and vehicle speed signals from the ABS module to adjust the projector module vertically to increase the beam range as the vehicle speed increases.

AFS CONTROL MODULE

The AFS control module is located on the instrument panel frame, behind the glove compartment.

The AFS control module is a dual functionality unit which also incorporates software to control the dynamic headlamp leveling. The AFS control module is connected to the high speed CAN bus and receives inputs from other vehicle systems on the status of the following parameters:

- Steering angle
- Vehicle speed
- Headlamp status
- Engine running
- Reverse gear selected
- Automatic lighting on.

The AFS will only operate when the AFS control module receives an engine running signal on the CAN bus. When the engine running signal is received the AFS control module performs an initialization routine.

The AFS will also function when the lighting control switch is in the AUTO position and the AFS control module receives a lights on signal from the rain/light sensor and an engine running signal.

The AFS control module then monitors the inputs from the other vehicle systems to control the AFS functionality according to cornering (steering) angles and vehicle speed.

The AFS control module is connected to each AFS power module on a private Local Interconnect Network (LIN) bus. The power modules read operating values supplied from the AFS control module and control the output drivers for the stepper motor actuators inside the headlamp assembly.

AFS OPERATION

The AFS controls the swiveling angle of each projector module using speed and steering angle signals. The angles of each projector module differ to give the correct spread of light, e.g. when turning left, the left hand projector module will have a greater swiveling angle than the right hand projector module.

INITIALIZATION PROCEDURE

When the AFS control module receives an ignition on signal, the control module performs the initialization procedure which ensures that the headlamps are correctly aligned on both their vertical and horizontal axes.

The AFS swivel initialization starts less than 1 second after the headlamp leveling initialization is activated to ensure that the headlamps are at or below the 0 degree position in the vertical axis, thus preventing glare to oncoming vehicles. The AFS swivel initialization is completed in less than 2.5 seconds. The LH and RH AFS actuator motors are powered from the 0 degree position to a small movement to the inboard position, then another small movement to the outboard position and then back to the 0 degree position.

FAILURE MODE

In the event of a failure of the AFS system, a warning indicator in the instrument cluster is illuminated to warn the driver. The AFS warning indicator illuminates when the ignition is in power mode 6 (ignition on) and will flash continuously until the fault is rectified. The AFS warning indicator will also be illuminated if a failure of the steering angle sensor or the vehicle speed signal is detected.

Illumination of the AFS warning indicator does not necessarily mean that there is a fault with the AFS system. The fault may be caused by a failure of another system preventing the AFS system operating correctly.

The AFS control module performs a diagnostic routine every time AFS is requested. If any fault is found, the AFS control module will suspend the operation of the AFS function.

If the AFS leveling system has failed with the xenon projector module in a position other than the correct straight ahead position, the AFS control module will attempt to drive the projector module to a position a small amount lower than the standard position. If the swivel function has failed, the AFS control module will lower the projector module using the leveling actuator motors to a position much lower than standard to prevent excess glare to oncoming vehicles.

The AFS control module software can detect an internal failure of the control module control circuits. The control module will power the projector modules to the zero position and prevent further operation.

Faults can be investigated by interrogating the AFS control module using the Land Rover recommended diagnostic tool to check for fault codes.

STATIC BENDING/CORNERING LAMPS

NOTE:

The static bending/cornering lamps are not fitted to NAS vehicles with AFS headlamps

The static bending/cornering lamps, which are a standard feature on AFS headlamps, are designed to illuminate the direction of travel when cornering at low speeds. The static bending/cornering lamp functionality, which is controlled by the CJB, is unique to vehicles with AFS headlamps and operates using inputs from the steering angle sensor.

The static bending/cornering lamp LED's are incorporated into the outer part of the headlamp assembly. The design of the lens projects a spread of light from the vehicle at approximately 45 degrees to the vehicle axis.

The static bending/cornering lamp uses 2 high power LED's located in the headlamp housing. The LED's are not serviceable components.

Cornering Lamp Functionality

The cornering lamps are designed to illuminate the direction of travel when cornering at low speeds. The design of the lens projects a spread of light from the vehicle at approximately 45 degrees to the vehicle axis.

The cornering lamps are controlled by the LH steering column multifunction switch with the lighting control switch in the headlamp position and the ignition switch in power mode 6 (ignition on). The cornering lamps are supplied power with power mode 6 to ensure that they do not function with the headlamp delay feature. The cornering lamps are deactivated if the vehicle speed exceeds 25 mph (40 km/h) at which point the static bending lamp functionality is activated.

Only one cornering lamp will illuminate at any one time. If the LH turn signal indicators are selected on, the left hand cornering lamp will be illuminated and visa versa, providing the vehicle speed and lighting control switch positions are correct.

Static Bending Lamp Functionality

The static bending lamps operate with a steering angle sensor CAN signal and vehicle speed signal which is received by the AFS control module and the CJB. The AFS control module sends a static bending lamp on request to the CJB which activates the static bending lamp LED's

When the operation parameters of the lamp are reached, the CJB illuminates the static bending lamp LED's on using a full power Pulse Width Modulation (PWM) voltage. When the lamp is switched off, the CJB fades the LED's off by decreasing the PWM voltage in a linear manner.

AUTOMATIC HEADLAMPS

The automatic headlamp function is a driver assistance system. The driver can override the system operation by selection of side lamps or headlamps on if the ambient light conditions require front and rear lighting to be active.

The automatic headlamp system uses a rain/light sensor which is connected via the Local Interconnect Network (LIN) bus to the CJB to control the headlamp functionality. The light sensor is incorporated in the rain/light sensor located on the inside of the windshield, below the rear view mirror. The wiper system also uses the rain/light sensor for automatic wiper operation. Refer to the Wipers and Washers section for details of the rain/light sensor and automatic wiper operation. For additional information refer to Wipers and Washers 501-16.

The light sensor measures the ambient light around the vehicle in a vertical direction and also the angular light level from the front of the vehicle. The rain/light sensor uses vehicle speed signals, wiper switch position and the park position of the front wipers to control the system.

The rain/light sensor can detect if the vehicle has entered a tunnel or similar environment and will activate the headlamps on entry to the tunnel when the ambient and forward light levels have fallen quickly. When the tunnel is exited, the rain/light sensor detects the sudden increase in light levels and requests the lights to be switched off.

Certain light and weather conditions are not detected accurately by the rain/light sensor. The driver should override the automatic headlamps function if in any doubt about weather conditions and the requirement for exterior lights to be active.

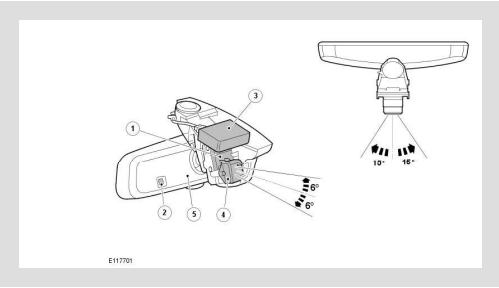
The automatic headlamp operation uses ambient light levels which are monitored by a photodiode incorporated in the rain/light sensor. The rain/light sensor sends a lights on/off request to the CJB via the LIN bus, which responds by switching on the low beam headlamps, front side lamps and rear tail lamps. The automatic headlamps are activated under the following conditions:

- Twilight
- Darkness
- Rain
- Snow
- Tunnels
- Underground or multi-level car parks.

Operation of the automatic headlamps requires the ignition to be in power mode 6 (ignition on), the lighting control switch to be in the 'AUTO' position and a lights on request signal from the light sensor.

If the automatic headlamp function has been selected and the ambient light falls below a pre-defined level then the front and rear fog lamps can be manually activated. If the ambient light rises above that level then the fog lamps will be deactivated along with the rest of the lamps. If the ambient light then falls below this level again the lamps will be activated, but the fog lamps which were previously selected will not.

HIGH BEAM ASSIST



ITEM	DESCRIPTION
1	Rear view mirror calibration bracket
2	Ambient light sensor (High beam assist)
3	Rain/light sensor (Auto headlamps)
4	Image sensor
5	High beam assist control module (inside mirror body)

High beam assist is a driving aid which automatically controls the high beam function. If required, the system can be overridden by the driver.

CAUTION:

The high beam assist system is designed as a driving aid only. Should the road conditions require, it is the driver's responsibility to consider other road users and operate the high beam headlamps in a safe manner. In certain circumstances the driver will be required to intervene.

High Beam Assist Warning Indicator

ITEM	DESCRIPTION
1	Warning indicator (green)

The high beam assist system is controlled by a high beam assist control module which is located in the interior rear view mirror body and by the CJB. The module and the CJB are connected via the medium speed CAN bus.

The high beam assist control module receives a power supply from the CJB when the ignition is in power mode 6 (ignition on). The rear view mirror also includes a low resolution camera (image) sensor which detects headlamps and tail lamps of preceding vehicles. The sensor is connected to the control module which evaluates the image data, checking for light intensity and location.

If conditions are correct, the control module will activate the high beam assist by sending a high or low beam request message to the CJB via the medium speed CAN bus. The CJB then controls the shutter in the Xenon projector module together with the high beam fill-in lamp.

HIGH BEAM ASSIST OPERATION

The high beam assist operates as part of the automatic headlight system. When driving at night with the lighting control switch in the automatic position and the LH steering column multifunction switch in the central position, with sufficient darkness (approximately 1 lux or less) and a suitable road speed, the high beam assist will automatically operate the high beam lighting when necessary. A warning symbol in the instrument cluster confirms to the driver when the high beam assist system is selected and enabled.

NOTES:

- The function of the normal 'blue' high beam indicator remains unchanged and it always reflects the actual status of the high beam lamps
- The exterior lighting 'on' threshold for the auto headlamps system is approximately 100 lux which is measured by the rain/light sensor. At light levels below this value the low beam headlamps and exterior lights will be switched on. The high beam assist will not function until the light level has reached approximately 1 lux. At light levels above 1 lux high beam is not required and therefore is not activated.

Activation (system ready)

High beam assist will only activate and illuminate the warning indicator to show system is ready or 'primed' for high beam control, when the following conditions are met:

- High beam assist has been first 'enabled' via the instrument cluster menu
- Lighting control switch is in the 'Auto' position
- LH steering column multifunction switch in the central position
- The ambient light level is below 100 lux – refer to 'Light Levels' section that follows
- The system has not been overridden or cancelled – refer to 'Override' section that follows
- The camera (image) sensor view is not blocked.

High Beam Control

When activated, high beam assist will switch the headlamps to high beam when all the following conditions occur:

- No relevant oncoming traffic
- No relevant preceding traffic
- In non-urban environment, i.e. with no street lighting
- Ambient light level is below 1 lux – refer to 'Light Levels' section that follows
- Road speed is suitable – refer to 'Road Speed' section that follows.

Low Beam Control

When activated, high beam assist will switch the headlamps to low beam when any of the following conditions occur:

- Relevant Oncoming traffic is present
- Relevant Preceding traffic is present
- In urban environment, i.e. with street lighting
- Ambient light level is above 1 lux – refer to 'Light Levels' section that follows
- Road speed is not suitable – refer to 'Road Speed' section that follows
- Unrecognisable reflective inputs from road signs or markings – refer to 'System Limitations' section that follows.

Light Levels

The exterior lighting 'on' threshold for the normal 'auto headlamps' feature is approximately 100 lux and is measured by the windscreen mounted 'rain/light' sensor. When the light level falls to this value the low beam headlamps and exterior lights will be switched on together with the high beam assist warning indicator.

This warns the driver that the system is activated and ready to automatically switch on the high beam headlamps when the light level falls a little further to approximately 1 lux, as measured by the 'ambient light sensor' located in the mirror body. High beam is generally not required with light levels above 1 lux.

Road Speed

A road speed signal is received by the CJB from the Anti-lock Braking System (ABS) module via the high speed CAN bus. When the other activation conditions are correct, the CJB will switch the headlamps to high beam when the road speed has increased above 40 km/h (25 mph).

When the road speed falls to below 24 km/h (15mph), the CJB will switch the headlamps to low beam. The 10 mph (15 km/h) difference between the on and off road speed thresholds prevents the system continually switching between high and low beam at low speeds.

Override

The driver can manually override the high beam assist system at any time. When the high beam assist system is activated, pulling the LH steering column multifunction switch to the high beam 'flash' position or pushing it forward to the high beam position will de-activate the system and the high beam assist warning indicator in the instrument cluster will extinguish.

When the multifunction switch is returned to the central position, from a forward high beam position, the system is re-activated and the high beam assist warning indicator will illuminate again.

Correct Performance

In addition, high beam assist will only exhibit best performance if all of the following conditions are met:

- No false inputs are received by the camera (image) sensor, such as reflected light from certain static signs – refer to 'System Limitations' section that follows
- Headlamps are correctly aligned

- High beam assist system has been set for correct 'hand of traffic' via the driver menu settings – refer to 'Setting Hand of Traffic' section that follows
- Headlamps have been set for correct 'hand of traffic' via the mechanical tourist lever in headlamp casing – refer to 'Setting Hand of Traffic' section that follows
- Camera (image) sensor has been through a self learning 'auto aim' calibration procedure if any components have been replaced – refer to 'Calibration' section that follows
- There are no large reflective items, white papers, etc., sitting on top of the dash board in near view of the camera (image) sensor, or stickers placed directly in front of the camera (image) sensor

Driver Menu Features

The high beam assist feature must first be enabled using the configuration menu available in the instrument cluster. However if required, the high beam assist system can be permanently disabled leaving the basic 'Auto Lamps' system still operative.

Within this menu the system can also be configured for driving on the alternate side of the road (Hand of Traffic). This enables the system to be used in different regions and it's setting is important for correct operation.

Setting 'Hand of Traffic' and High Beam Assist 'Enable'

To set the high beam assist options the following steps must be sequenced:

- With the ignition in power mode 6 (ignition on), and the engine not running, use the controls on the steering wheel to select on the instrument cluster menu:
  - Menu > Vehicle Set-up > High Beam Assist
- Configure the 'Hand of Traffic' setting by selecting the appropriate 'Drive on Left' (of road) or 'Drive on Right' (of road) to the applicable Market condition
- Enable the feature by setting 'Activate Assist' if not already selected.

NOTES:

- Enabling or disabling high beam assist will not affect the ‘Hand of Traffic’ settings once set.
- The headlamps still require manual adjustment using the tourist lever for driving abroad in countries where the alternate side of the road is used.

The instrument cluster menu also includes a 'High Beam Assist Sensitivity' selection. This is a requirement option for NAS market vehicles only but it is not recommended for normal use and has been superseded.

NOTE:

In other markets the 'Sensitivity' selection is greyed out and cannot be selected.

For additional information, refer to:Instrument Cluster (413-01, Description and Operation).

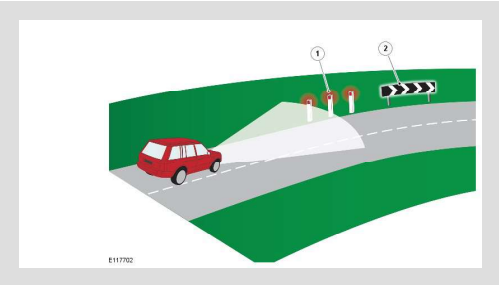
System Limitations

The high beam assist system can occasionally have difficulty distinguishing between light from other vehicles or reflected light from static highly reflective road signs.

These situations may cause the high beam assist system to undesirably operate the high beam headlamps or take no action at all. Examples of these situations are as follows:

- Dips, hollows or crests in the road
- Highly reflective static Road signs
- Tight bends
- Poorly illuminated vehicles e.g. cyclists or small mopeds
- Motorway central barriers
- Extreme weather conditions e.g. Fog, heavy snow
- Exterior domestic or industrial lighting

Reflective Static Signs



ITEM	DESCRIPTION
1	Red reflective signs could be detected as rear tail lamps
2	Large reflective signs could affect the system

Manual Deactivation

ITEM	DESCRIPTION
1	Vehicle equipped with high beam assist
2	Oncoming vehicle headlamps can be seen by the driver before the high beam assist image sensor detects the oncoming light

ITEM	DESCRIPTION
	input

There are situations when a driver is able to judge if a high beam deactivation is desirable before the high beam assist system actually operates, for example over a crest of a hill. Headlamps from an oncoming vehicle can sometimes be seen on the horizon prior to the detection sensor receiving an input. It is the driver's preference to determine if early intervention is desired in this and similar situations.

System Diagnosis

> **NOTE:**
>
> Windshield stickers, stone chips, dirt and general road film will affect the successful operation of the image sensor if sufficient blocking is present. Avoid placing reflective objects on the instrument panel, for example white paper which can affect the image sensor.

High beam assist has a self diagnosis capability by comparing data from the ambient light sensor input (located in the rear view mirror) to light levels detected by the image sensor. If a deviation is detected it is assumed that the ambient light available to the image sensor is being restricted by dirt or other blockage and the system will be deactivated. Diagnostic Trouble Code (DTC)'s are stored in the control module's memory and can be accessed using an approved Land Rover diagnostic system. Within the diagnostic system is a procedure to test the basic operation of the camera function.

In the event of a fault, the warning strategy to the driver is as follows:

- Image sensor internal fault - green icon will extinguish with no additional message to driver
- CJB has lost all communication with image sensor - green icon will extinguish with no additional message to driver
- Image sensor blocked - green icon will extinguish with an additional "High Beam Assist Sensor Blocked" message within the message centre

System Calibration

To achieve effective operation of the high beam assist system, a calibration routine is performed on vehicle build and system tolerances are set to an accuracy of +/- 0.2 degrees.

This initial calibration is a 'one time only' procedure. Should the high beam assist components or the windshield require replacement at the dealership, an automatic calibration routine will be performed. This 'auto aim' calibration procedure is a continual process that takes place during a normal drive cycle at night and could take between 10 - 30 minutes dependant on the following driving conditions:

- If sufficient road markings (lane markings) are visible to the image sensor - approximately 10 minutes
- If insufficient road markings are visible, the system uses the tail lights of preceding vehicles - approximately 30 minutes.

NOTES:

- Until this calibration is complete the system may not react correctly during operation. This should be made clear to the customer before vehicle handover. During any calibration or rectification work the headlamps should be checked for correct alignment.
- Due to mechanical calibration tolerance the correct mirror assembly must be used for the vehicle model types in question and it is not exchangeable with other vehicle model types.
- After any rectification work and before any calibration drives, the headlamps should be checked for correct alignment.

HEADLAMP DELAY

The CJB controls a headlamp delay function which illuminates the driveway after leaving the vehicle. The headlamp delay will operate on low beam headlamps only regardless of the position of the left hand steering column multifunction switch.

The headlamp delay is activated when the lighting control switch is in the 'Auto' position and the engine is switched off. The message center displays a 'HEADLIGHT DELAY' message and the low beam headlamps will be activated for a period of approximately 30, 60, 120 or 240 seconds, which is selectable using the instrument cluster menu. After the delay period, the CJB automatically switches off the delay function, extinguishing the headlamps.

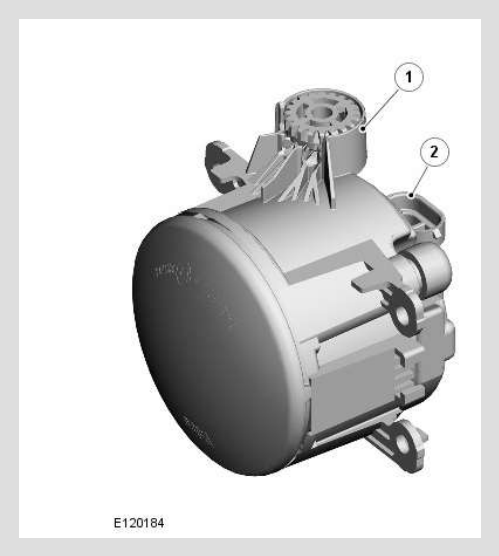
The headlamp delay feature can also be switched off by pressing the headlamp button on the smart key.

INSTRUMENT CLUSTER WARNING INDICATOR ILLUMINATION

The warning indicators in the instrument cluster for left and right turn signal indicator, front and rear fog lamps and headlamp low and high beam and side lamps are activated by the CJB via messages to the instrument cluster on the medium and high speed CAN buses. The synchronisation of the turn signal warning indicator with the external turn signal indicator lamp frequency is controlled by a cyclic transmission of the light status on the medium speed CAN bus.

The AFS warning indicator is controlled by a signal from the AFS control module.

FRONT FOG LAMPS

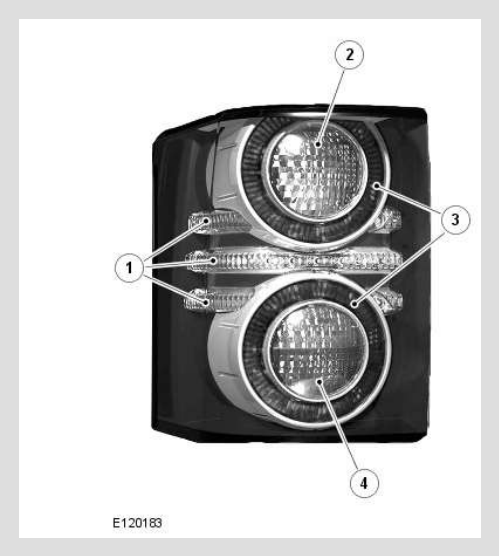


ITEM	DESCRIPTION
1	Lamp assembly
2	Bulb holder

The front fog lamps are located in the front bumper. Each lamp is secured to three lugs in the bumper and retained with self tapping screws and fasteners. Each lamp has an adjustment thumbwheel which provide for the vertical alignment of the beam. Access to the thumbwheel requires removal of the lamp bezel.

The 55W halogen bulb is located in a holder. The holder is secured in the lamp housing by rotating through approximately 10°. The holder has a connector to allow for connection to the electrical harness.

TAIL LAMP ASSEMBLY



ITEM	DESCRIPTION
1	Turn signal indicator LED's (12 off)
2	Stop lamp LED's (19 off)
3	Tail lamp LED's (21 off)
4	Fog lamps LED's (3 off)

The rear tail and turn signal indicator lamp assemblies are located on the outer corner of each rear wing panel.

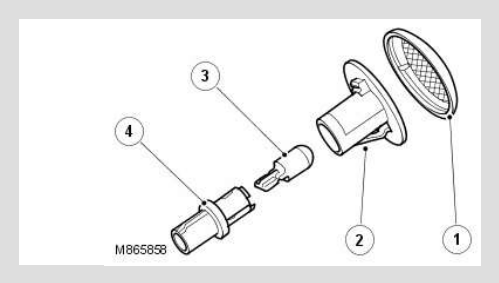
The lamp assembly is retained by two integral plastic clips which locate in corresponding clips secured to the body panel. The assembly is further retained by two self tapping screws which are accessed from inside the tailgate aperture. To remove the assembly, after removing the screws, the assembly must be prized at two indentations to release the clips. A non-metallic tool must be used with care to avoid damage to the paint finish and the lamp assembly.

All lamps in the tail lamp assembly use LED's's. The stop lamp is located in the upper section of the lamp assembly and is illuminated by 19 LED's. Surrounding the stop lamp is the upper tail lamp which is illuminated by 9 LED's. The rear fog lamp is located in the lower section of the tail lamp assembly and is illuminated by 3 high power LED's. Surrounding the fog lamp is another circular ring of 12 LED's which function as the lower tail lamp. The turn signal indicators are 3 horizontal strips located between the upper and lower tail lamps and are illuminated by 12 LED's.

On NAS vehicles, an additional LED is used to accommodate the side marker lamp. The LED lens has a vertical section which is used as the side marker illumination required for the NAS market.

None of the LED's are serviceable items.

SIDE REPEATER LAMPS



ITEM	DESCRIPTION
1	Lens
2	Lamp body
3	Bulb
4	Bulb holder

The side repeater lamps are located in the front fenders, forward of the louvered air vents. The side repeater lamps are clipped into the fender aperture and can be removed by pushing forwards and pulling outwards from the fender.

The side repeater lamps use a capless 5W bulb which is pressed into contacts in a holder. The holder is located in the lamp assembly. These lamps are not monitored by the CJB and if a failure occurs the driver will not receive a message.

REVERSING LAMPS

The reversing lamps are located in the lower tail door and positioned at either side of the license plate. The lamps are secured in the tail door with a clip at the bottom and positively secured with a screw at the top.

Each reversing lamp uses a 6W bayonet type bulb.

LICENSE PLATE LAMPS

Two license plate lamps are located in the trim above the license plate in the lower tail door. The lamps are press fitted in their apertures and secured by an integral plastic clip.

Each lamp uses a 5W festoon type bulb.

HAZARD WARNING LAMPS

The hazard warning lamps use the front and rear turn signal indicator lamps as previously described. These are controlled by the CJB in response to a hazard warning lamp request from the instrument panel switch.

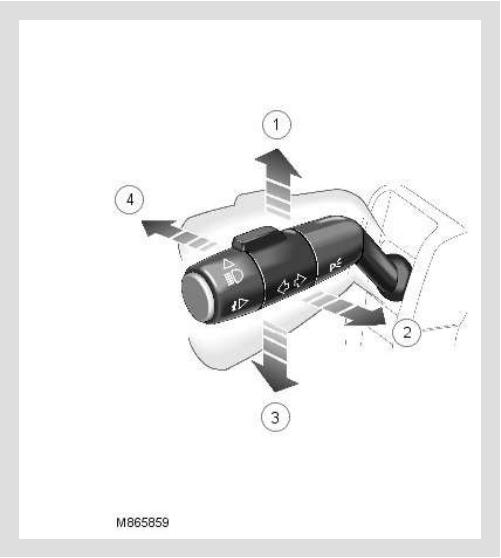
CRASH SIGNAL ACTIVATION

In the event of an accident of a severity to activate and deploy the airbags, the RCM requests various electrical operations to assist with the crash situation. The RCM requests via the bus systems to the CJB to activate the hazard warning lamps. These will continue to operate until deselected using the hazard warning lamp switch in the instrument panel. The lamps flash at a frequency which is the same as the frequency used to flash the headlamp high beam in the same situation.

DAYTIME RUNNING LAMPS (DRL)

DRL operation is detailed in a separate section. For additional information refer to 417-04 Daytime Running Lamps.

LEFT HAND STEERING COLUMN MULTIFUNCTION SWITCH



ITEM	DESCRIPTION
1	RH turn signal indicator
2	Headlamp flash
3	LH turn signal indicator
4	Headlamp high beam

The left hand steering column multifunction switch is located on the left hand side of the steering column and controls the following functions:

- Headlamp low/high beam
- Headlamp high beam flash
- Left/right turn signal indicators
- Trip computer functions. For additional information refer to 413-08 Information and Message Center.

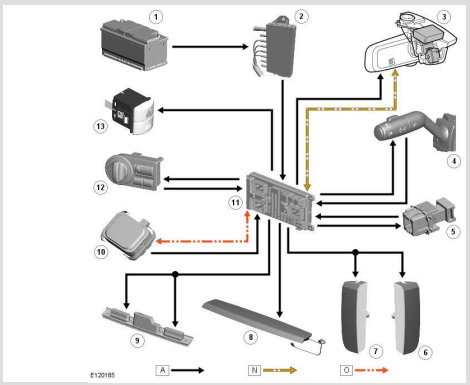
The high beam on and flash functions are connected on a single wire to the cjb. The switch assembly contains resistors and the ground for each selection is passed through a different resistor for each selection. The same also applies to the turn signal indicators. The cjb senses the resistance on the ground wire and determines which function has been selected.

The turn signal indicators incorporate a lane change function. To activate the lane change function, hold the lever partially up or down against spring pressure to indicate a lane change. The directional indicator will flash three times. The lane change function can be enabled or disabled using an approved Land Rover diagnostic system.

EXTERIOR LIGHTING CONTROL DIAGRAM - SHEET 1 OF 2

NOTE:

A = Hardwired; **D** = Medium Speed CAN bus; **O** = LIN Bus.



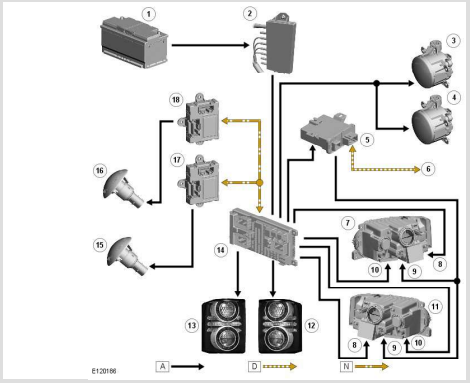
ITEM	DESCRIPTION
1	Battery
2	BJB
3	Auto high beam control module and image sensor
4	LH steering column multifunction switch
5	Brake switch

ITEM	DESCRIPTION
6	RH reversing lamp
7	LH reversing lamp
8	High mounted stop lamp
9	Licence plate lamps
10	Rain/light sensor
11	CJB
12	Lighting control switch
13	Hazard warning lamp switch

EXTERIOR LIGHTING CONTROL DIAGRAM - SHEET 2 OF 2

NOTE:

A = Hardwired; **D** = High speed CAN bus; **N** = Medium speed CAN bus



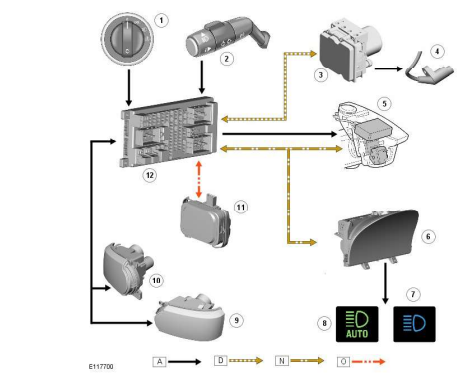
ITEM	DESCRIPTION
1	Battery
2	BJB
3	LH front fog lamp
4	RH front fog lamp
5	Adaptive Front lighting System (AFS) (if fitted)
6	High speed CAN bus to other systems
7	RH headlamp assembly
8	LED control module - side lamps and side marker lamps (NAS only)

ITEM	DESCRIPTION
9	Xenon control module
10	LED control module - Turn signal indicator and static bending lamp (if fitted)
11	LH headlamp assembly
12	RH tail lamp assembly
13	LH tail lamp assembly
14	CJB
15	RH side repeater lamp
16	LH side repeater lamp
17	RH door module
18	LH door module

AUTO HIGH BEAM CONTROL DIAGRAM

NOTE:

A = Hardwired; **D** = High Speed CAN; **N** = Medium Speed CAN; **O** = LIN Bus



ITEM	DESCRIPTION
1	Lighting control switch
2	LH steering column multifunction switch
3	ABS control module
4	Wheel speed sensor
5	Auto high beam control module and image sensor
6	Instrument cluster

ITEM	DESCRIPTION
7	High beam warning indicator
8	Auto high beam warning indicator
9	LH headlamp assembly
10	RH headlamp assembly
11	Rain/light sensor
12	CJB