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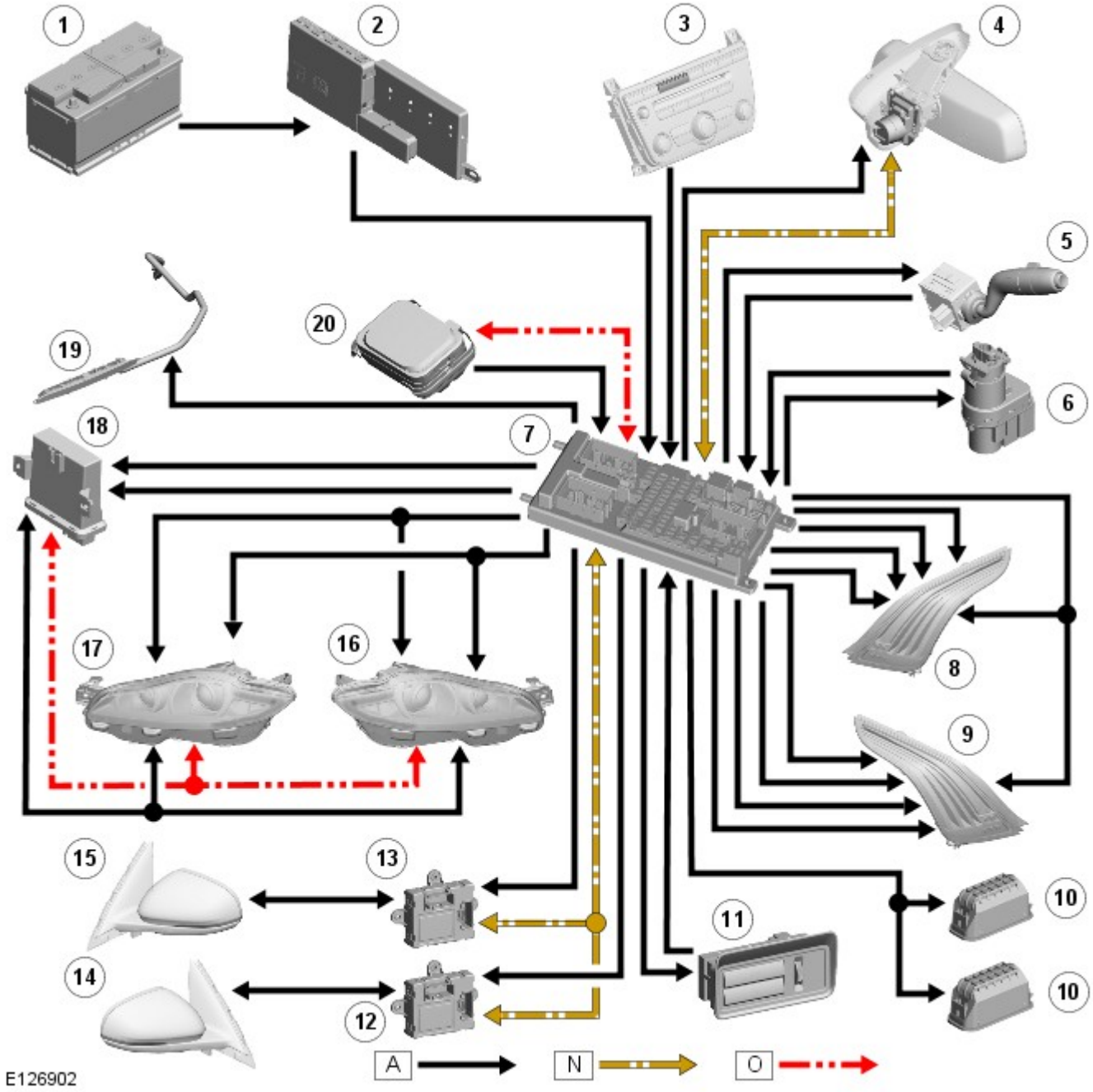
Exterior Lighting - Exterior Lighting - System Operation and Component Description

Description and Operation

Control Diagram

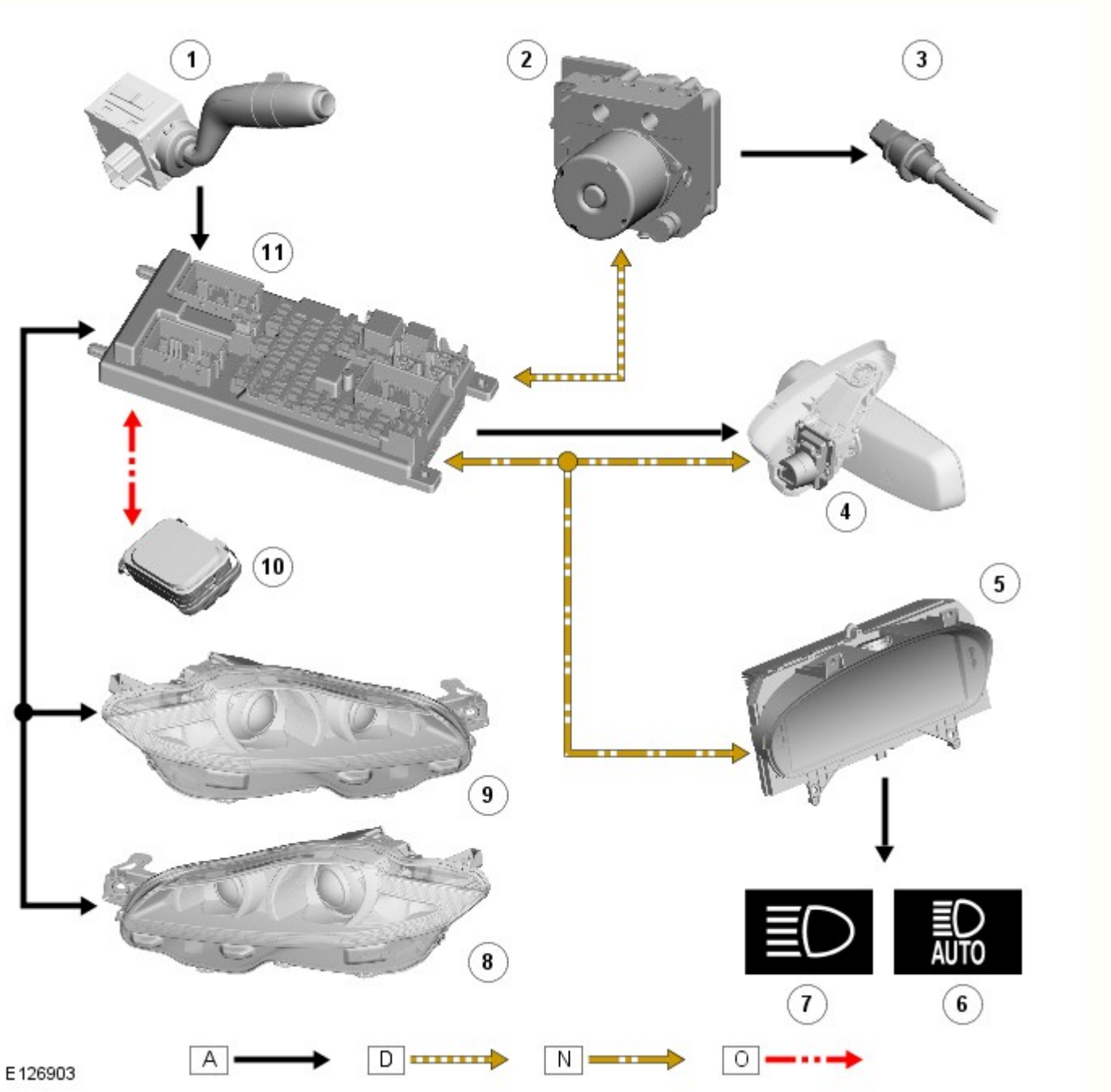
EXTERIOR LIGHTING - CONTROL DIAGRAM



Item	Description
	NOTE: **A** = Hardwired; **N** = Medium speed CAN bus; **O** = LIN bus
1	Battery
2	Battery Junction Box (BJB)
3	Hazard warning lamp switch
4	Auto High Beam (AHB) Module
5	Left Hand (LH) steering column multifunction switch
6	Brake switch
7	Central Junction Box (CJB)
8	LH tail lamp

9	Right Hand (RH) tail lamp
10	License plate lamp (2 off)
11	Rear fog lamp switch
12	Passenger door module
13	Driver's door module
14	RH turn signal indicator side repeater lamp
15	LH turn signal indicator side repeater lamp
16	RH headlamp assembly
17	LH headlamp assembly
18	Headlamp control module (AFS headlamps only)
19	High mounted stop lamp
20	Rain/light sensor

AUTO HIGH BEAM CONTROL DIAGRAM



Item	Description
	NOTE: **A** = Hardwired; **D** = High Speed CAN; **N** = Medium Speed CAN; **O** = LIN Bus
1	LH steering column multifunction switch

2	Anti-lock Brake System (ABS) control module
3	Wheel speed sensor
4	Auto high beam control module and image sensor
5	Instrument cluster
6	Auto high beam warning indicator
7	High beam warning indicator
8	LH headlamp assembly
9	RH headlamp assembly
10	Rain/light sensor
11	Central Junction Box (CJB)

System Operation

CENTRAL JUNCTION BOX (CJB)

The CJB (central junction box) is located behind the rear seat center armrest and is connected to the vehicle wiring harness with 8 multiplugs.

The CJB receives 2 permanent battery power supplies via the BJB (battery junction box) .

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 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 switch for the 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 resistive ladder, the output voltage of which is detected by the CJB which in turn determines the selected position.

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 (controller area network) bus from the TCM (transmission control module) to enable the CJB to activate the reverse lamps.

The CJB can receive a hazard warning indicator activation message from the RCM (restraints control module) , 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/LED Monitoring

Bulb/ LED (light emitting diode) 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 DTC (diagnostic trouble code) which can be retrieved using an approved Jaguar 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 Jaguar 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 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 Signal 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.

LIGHTING CONTROL SWITCH

The CJB outputs 2 reference voltages to the rotary lighting control switch; one feed being supplied to the lighting function of the switch and the second feed being supplied to the auto headlamp exit delay function. The switch position is determined by CJB by the change in returned signal voltage which is routed through up to 4 resistors in series depending on the selection made.

Lighting functions

OFF - When the lighting control switch is in the off position, the reference voltage flows through 1 of the resistors. The returned signal voltage is detected by the CJB which determines that no lighting selection is made. The reference voltage to the auto headlamp exit delay switch is routed through 4 resistors which is detected by the CJB which determines that auto headlamp or exit delay has not been selected.

SIDE LAMPS - When the lighting control switch is in the side lamp position, the reference voltage flows through 2 of the resistors. The returned signal voltage is detected by the CJB which activates the side lamps. The reference voltage to the autolamp exit delay switch is routed through 4 resistors which is detected by the CJB which determines that auto headlamp or exit delay has not been selected.

HEADLAMPS - When the lighting control switch is in the headlamp position, the reference voltage flows through 3 of the resistors. The returned signal voltage is detected by the CJB which activates the headlamps. The reference voltage to the auto headlamp exit delay switch is routed through 4 resistors which is detected by the CJB which determines that auto headlamp or exit delay has not been selected.

AUTOLAMPS - When the lighting control switch is in the auto headlamp position, the reference voltage flows through 4 of the resistors. The returned signal voltage is detected by the CJB which activates the autolamp function. The reference voltage to the autolamp exit delay switch is routed through 4 resistors which is detected by the CJB which determines that auto headlamp has been selected.

High Beam

The CJB outputs a reference voltage to the LH (left-hand) steering column multifunction switch for operation of the high beam/flash function.

When the switch is in the central off position the reference voltage is passed through 3 resistors. The return voltage is detected by the CJB which determines that no selection has been made.

When the switch is moved forwards to the high beam position, the reference voltage is passed through 2 resistors. The return voltage is detected by the CJB which activates the high beam function of the bi-xenon headlamps.

When the switch is moved rearwards to the high beam flash position, the reference voltage is passed through 1 resistor. The return voltage is detected by the CJB which activates the high beam function of the bi-xenon headlamps for as long as the switch is operated.

Headlamp Delay Functions

EXIT DELAY 1 (30 seconds) - When the lighting control switch is moved to the exit 1 position, the reference voltage from the CJB flows through 3 resistors. The returned signal is detected by the CJB which activates the 30 second headlamp delay timer.

EXIT DELAY 2 (60 seconds) - When the lighting control switch is moved to the exit 2 position, the reference voltage from the CJB flows through 2 resistors. The returned signal is detected by the CJB which activates the 60 second headlamp delay timer.

EXIT DELAY 3 (120 seconds) - When the lighting control switch is moved to the exit 1 position, the reference voltage from the CJB flows through 1 resistor. The returned signal is detected by the CJB which activates the 120 second headlamp delay timer.

Turn Signal Indicators

The CJB outputs a reference voltage to the LH steering column multifunction switch for operation of the LH and RH (right-hand) turn signal indicators.

When the switch is in the central off position the reference voltage is passed through 3 resistors. The return voltage is detected by the CJB which determines that no selection has been made.

When the switch is moved to the LH position, the reference voltage is passed through 1 resistor. The return voltage is detected by the CJB which activates the LH turn signal indicators for as long as the switch is activated or for 3 flashes if the switch was operated for the lane change function.

When the switch is moved to the RH position, the reference voltage is passed through 2 resistors. The return voltage is detected by the CJB which activates the RH turn signal indicators for as long as the switch is activated or for 3 flashes if the switch was operated for the lane change function.

AUXILIARY LIGHTING SWITCH

Rear Fog Lamp Switch

The CJB supplies a reference voltage and return to the rear fog lamp switch. The fog lamp switch is a non-latching, momentary switch.

When the fog lamp switch is off the reference voltage is passed through a 1Kohm resistor. The voltage through the resistor is returned to the CJB which determines that no request for fog lamp operation has been made.

When the driver presses the fog lamp switch, the reference voltage is passed momentarily through a 330 ohm resistor. The change in return voltage is sensed by the CJB which determines fog lamp operation has been requested. The CJB provides a power supply to the 3 LED 's in each rear fog lamp. A fog lamp warning lamp in the instrument cluster will also be illuminated when the fog lamps are operating.

The CJB will only activate the rear fog lamps if the headlamps are selected ON or are active with auto headlamp activation. When the headlamps are turned off the fog lamps are also turned off. If the driver presses the fog lamp switch for a second time the rear fog lamps are also switched off. When the headlamps are next switched on, the fog lamps will not be activated until the driver requests fog lamp operation.

NOTE: The rear fog lamps do not operate when DRL (daytime running lamps) are active.

AUTOMATIC HEADLAMPS

Auto Headlamps

When the lighting control switch is in the auto headlamp position, a reference voltage from the CJB flows through 4 resistors in the lighting control switch. The returned signal voltage is detected by the CJB which activates the autolamp function. The reference voltage to the autolamp exit delay switch is also routed through 4 resistors of the same rating which is detected by the CJB which determines that auto headlamp has been selected.

The rain/light sensor receives a battery voltage output from the ignition relay in the CJB . The rain/light sensor continually outputs a LIN (local interconnect network) bus message to the CJB with information regarding the ambient light levels. When the ambient light level reaches a predetermined value, the CJB activates the auto headlamp feature. The CJB can also activate the auto headlamps when it receives information regarding rain fall from the rain/light sensor which subsequently activates the auto wipers function.

Auto High Beam (AHB)

The Auto High Beam (AHB) system is controlled by a AHB 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 AHB 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 AHB 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 Bi-Xenon projector module.

Component Description

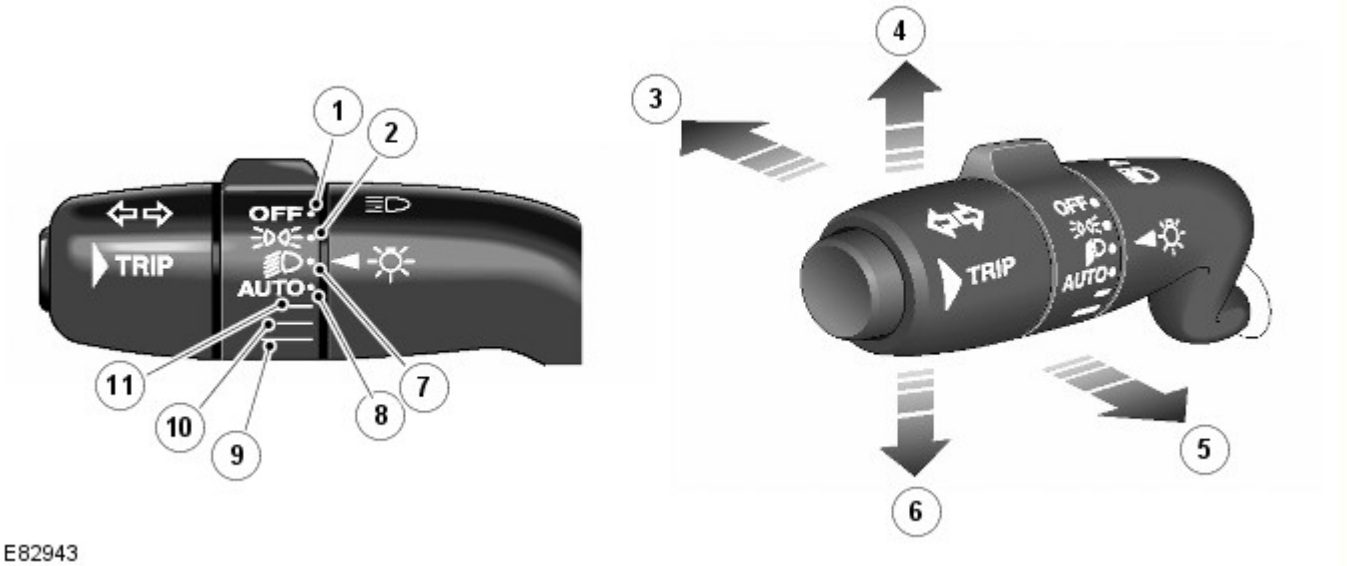
EXTERIOR BULB TYPE/RATING

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

NOTE: The tail lamps, side marker lamps, stop lamps, high mounted stop lamp and rear fog lamps are illuminated by LED 's and are non-serviceable components.

Bulb	Type	Rating
Xenon headlamp bulb	D3S	35W
Licence plate lamps - All markets	W5W	5W

LIGHTING CONTROL SWITCH



Item	Description
1	Off position
2	Side lamp position
3	High beam position
4	RH turn signal indicator
5	Headlamp flash/high beam off position
6	LH turn signal indicator
7	Headlamp position
8	AUTO headlamp position
9	Headlamp timer 120 second delay position
10	Headlamp timer 60 second delay position
11	Headlamp timer 30 second timer delay position

The lighting control switch is located on the LH steering column multifunction switch. The lighting control switch is a rotary control with positions for the following lighting functions:

- Off
- Side lamps
- Headlamps
- AUTO headlamps
- Headlamp timer (3 time period selections).

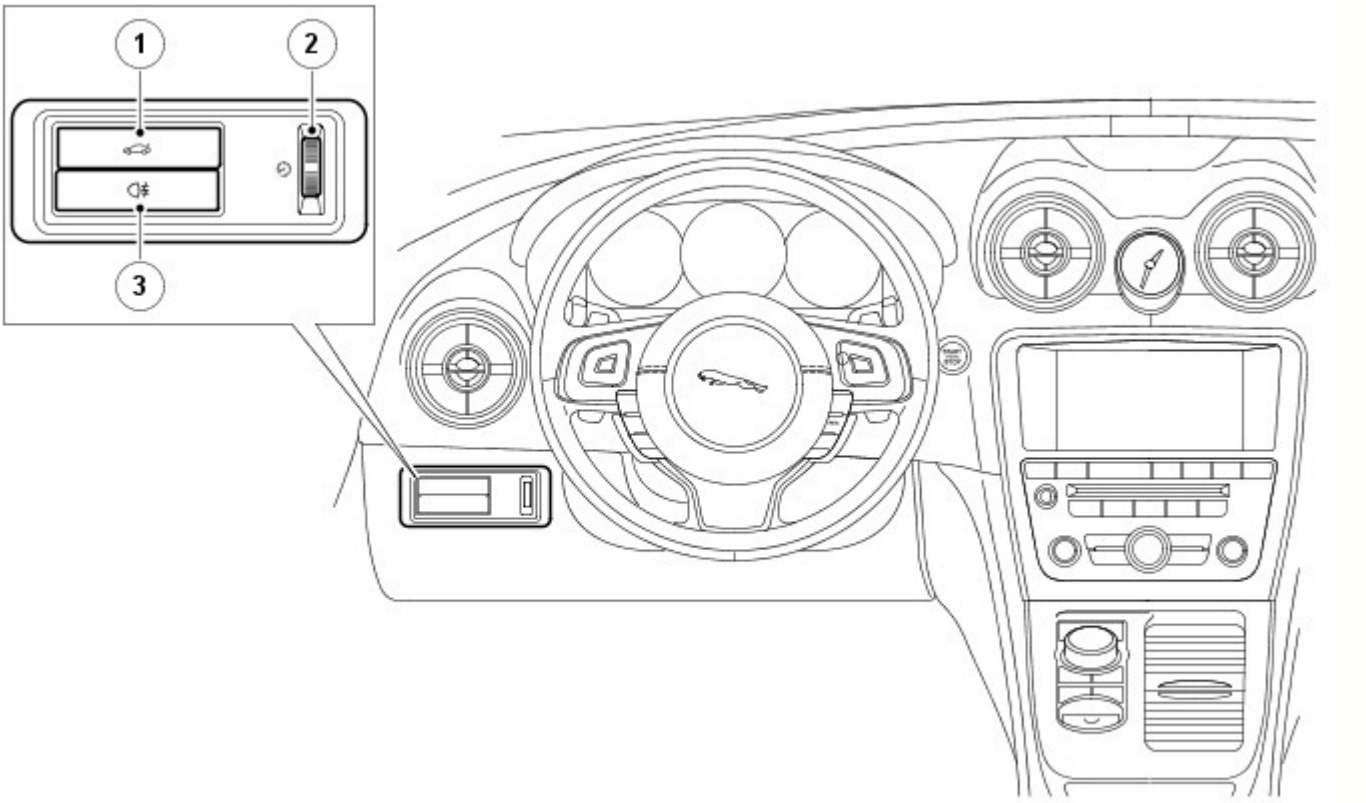
The LH steering column multifunction switch also provides for the following functions:

- Low beam headlamps
- High beam headlamps
- Headlamp flash
- LH and RH turn signal indicators
- Trip computer function button.
  Refer to: Information and Message Center (413-08 Information and Message Center, Description and Operation).

The switch has a turn signal indicator lane change function which is configurable by the dealer. If the switch is gently pushed to either turn signal indicator position and then released, the applicable turn signal indicators will flash 3 times and then will be automatically cancelled. If a turn signal indicator fails, the green turn signal warning indicator in the instrument cluster will flash at twice the normal rate and the audible ticking from the instrument cluster sounder will also be at twice the normal rate.

AUXILIARY LIGHTING SWITCH

NOTE: LHD (left-hand drive) switch shown



E126904

Item	Description
1	Luggage compartment lid release switch
2	Instrument panel illumination dimmer thumbwheel
3	Rear fog lamp switch

The auxiliary lighting switch is located in the instrument panel, adjacent to the steering column. The switch has a rear fog lamp switch and a rotary thumbwheel dimmer to adjust instrument panel illumination. The auxiliary lighting switch also has a luggage compartment release switch.

The rear fog lamp switch is a non-latching switch which provides a momentary signal to the instrument cluster. The fog lamps can only be activated if the ignition is in power mode 6 and the headlamps or auto headlamps are selected on. If the fog lamp switch is pressed when the fog lamps are operating, they will be switched off. If the lighting control switch is moved to the side lamp or off position or if the auto headlamps turns off the headlamps the rear fog lamps will be extinguished. If the headlamps are subsequently turned on the rear fog lamp operation will not be active and the rear fog lamp switch must be pressed to activate the lamps.

HEADLAMP ASSEMBLY

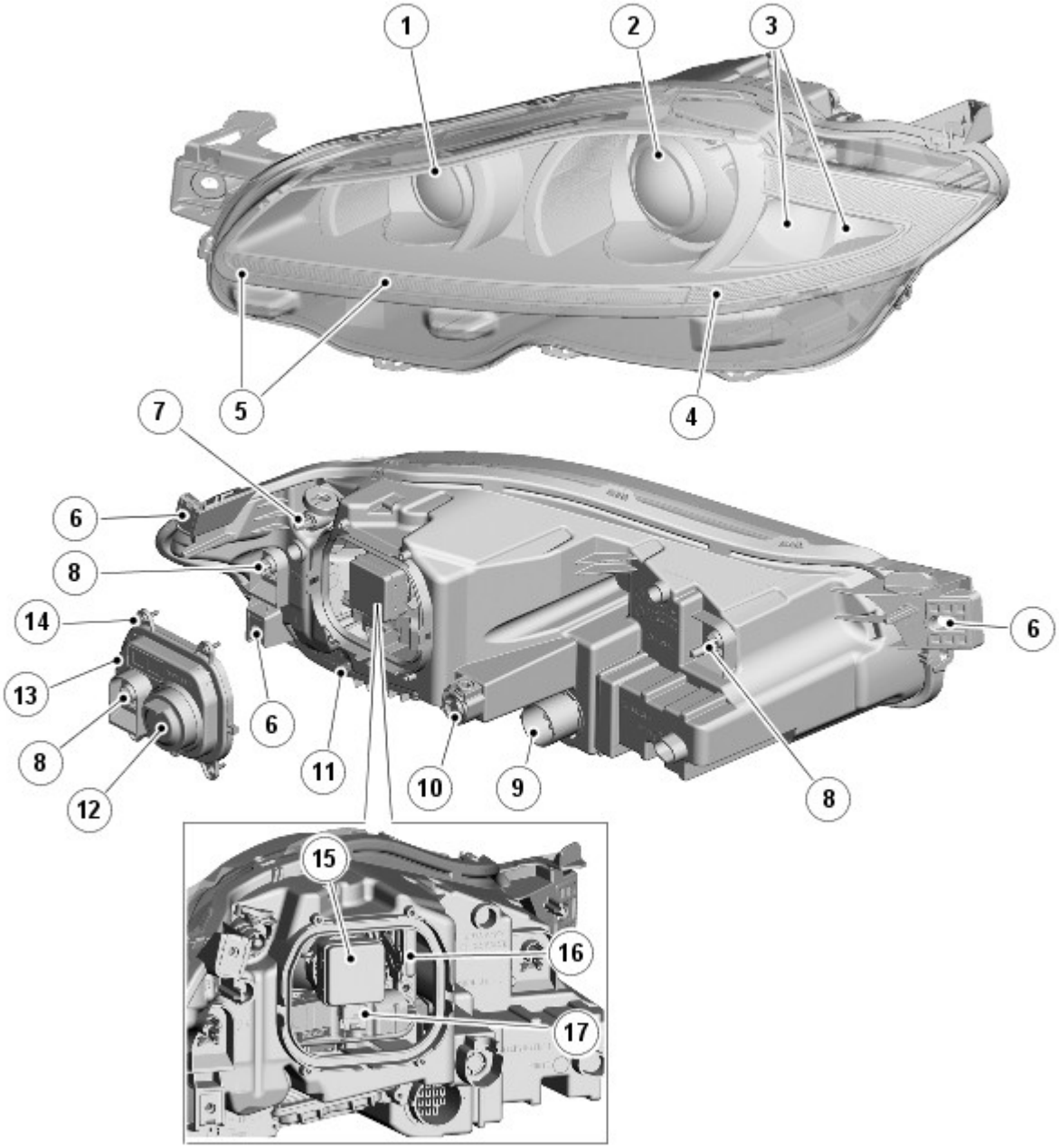
Two types of headlamp are available; xenon without Adaptive Front lighting System (AFS) or xenon with AFS. The headlamp is secured in the front of the vehicle with three bolts; 1 inboard bolt is screwed into the front upper cross member and 2 bolts located at the rear of the headlamp assembly and secure the headlamp to a fender support brackets which in turn is connected to the upper cross-member. Xenon bulb replacement requires the removal of the 3 bolts and the headlamp assembly.

The rear of the headlamp has an access panel which is secured with four screws. The panel allows access to the xenon bulb for replacement. A smaller rubber pull-off cover on the panel can be removed to access the tourist lever. Access to the panel and the pull-off cover is by partial removal of the wheel arch splash shield.

The headlamps have 2 adjustment screws on the rear which allow for the manual setting of the vertical and horizontal alignment.

On NAS vehicles, the headlamp is regarded as 'Visual Optically Left' aiming. The adjustment screws must be turned equal amounts to maintain the correlation in the vertical axis only. There is no horizontal adjustment. Refer to the Service Repair Procedures manual for headlamp alignment data and procedures.

Each headlamp has an integral 16 pin connector which provides inputs and outputs for the various functions of the headlamp assembly.



E126905

Item	Description
1	Turn signal indicator LED's
2	Projector module -Low/High beam headlamp
3	Cornering/static bending lamp LED's (if fitted)
4	Side marker lamp LED (NAS only)
5	Side lamp LED's
6	Headlamp mounting screw locations (3 off)
7	Headlamp beam adjuster
8	Headlamp breather vent (3 off)
9	Electrical connector
10	Headlamp beam adjuster
11	Xenon control module
12	Tourist lever access cover
13	Access panel
14	Access panel attachment screw (4 off)
15	Xenon bulb igniter
16	Tourist lever

17	Xenon ignitor electrical connector

Bi-Xenon Headlamp

The bi-xenon headlamp uses a projector module. The projector module comprises an ellipsoidal lens and a reflector. The projector reflector collects the light produced by the xenon bulb and projects the light into a focal plane containing a shield. The contour of the shield is projected onto the road by the lens.

A tourist lever mechanism is located on the right hand side of the 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 beam is changed by partial removal of the wheel arch splash shield and removing the access cover at the rear of the lamp assembly and moving a small lever located near the bulb holder, at the side of the projector.

 NOTE: The tourist lever is not fitted to NAS vehicles.

 WARNING: The Xenon system generates up to 30000 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 adhered to when working on the xenon low beam 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; for example 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 bulb in a mounted condition in the projector module installed in the headlamp.

The xenon headlamp is known as 'bi-xenon' because it operates as both a low and high beam headlamp unit. The xenon lamp, or High Intensity Discharge (HID) lamp as they are sometimes referred to, comprises an ellipsoidal lens with a solenoid controlled shutter to change the beam output from low to high beam.

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

The xenon headlamp is a self contained unit located within the headlamp assembly. The unit comprises a reflector, the lens, a shutter controller and the xenon bulb, which together form an assembly known as the projector module. The reflector is curved and provides the mounting point for the xenon bulb. The bulb locates in a keyway to ensure the correct alignment in the reflector and is secured by a plastic mounting ring. The bulb is an integral component 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 vice versa.

The xenon bulbs illuminate when an arc of electrical current is established between 2 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 3 full stages of operation before full output for continuous operation is achieved. The 3 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 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 the regulated power supply from the control modules.

Static Bending/Cornering Lamps

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 (ignition on) 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

 NOTE: Static bending lamps only operate when the transmission is in DRIVE or in SPORT.

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 PWM (pulse width modulation) voltage. When the lamp is switched off, the CJB fades the LED 's off by decreasing the PWM voltage in a linear manner.

Turn Signal Indicators

The turn signal indicator lamp is located in-board of the headlamp projector module. The indicator lamp comprises 8 amber LED 's arranged in a circular pattern.

When active, the turn signal indicator lamps will flash at a frequency cycle of 400ms on and 400ms off. If a bulb fails, the remaining turn signal lamps bulbs continue to flash at normal speed.

Side Lamps

The side lamp is located in a row along the bottom of the headlamp. The side lamp comprises 8 LED 's.

The side lamps are operated by selecting side lamps or headlamps on the lighting control switch. The side lamps are functional at all times and are dependant on a particular ignition mode status. The side lamps will also be illuminated when the lighting control switch is in the AUTO position and a 'lights on' signal is received by the CJB from the rain/light sensor.

Side Marker Lamps (NAS only)

The side marker lamp is located at the outboard end of the side lamps and is illuminated by a single amber LED . An amber reflex reflector continues from the end of the side marker lamp and forms a triangle around the static bending/corning lamp (where fitted).

The side marker lamp is active at all times when the side lamps are active.

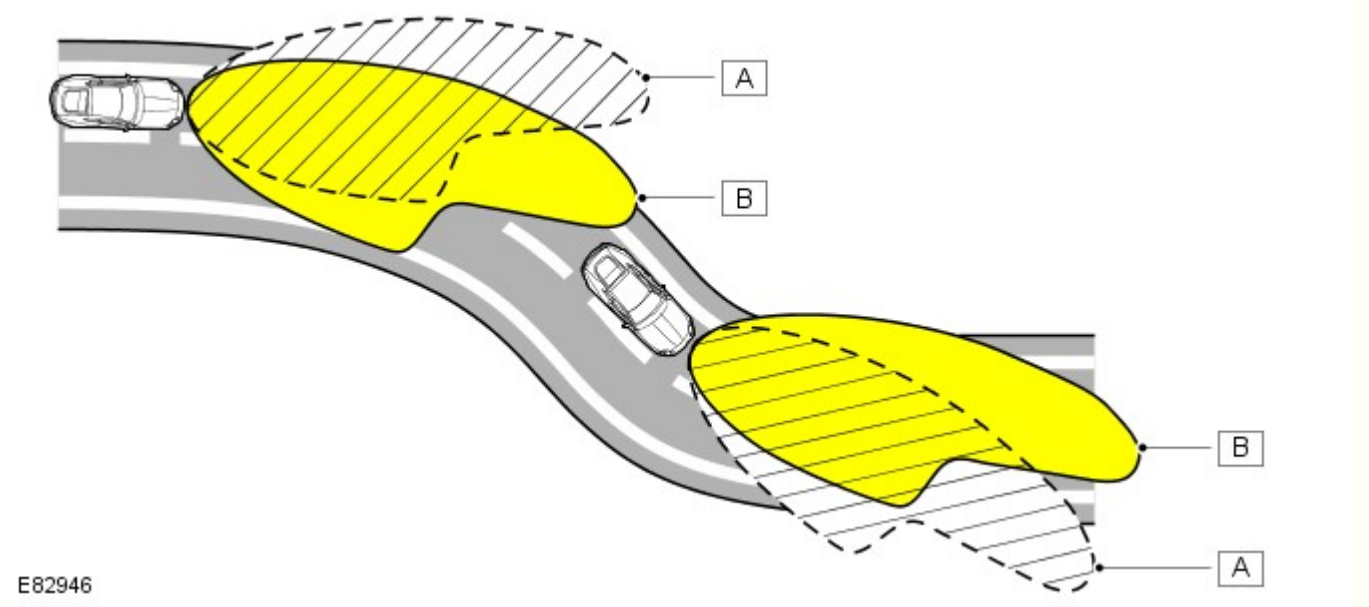
ADAPTIVE FRONT LIGHTING SYSTEM (AFS) HEADLAMPS

The AFS headlamp is similar in its construction to the xenon headlamp. 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 adaptive bi-xenon™ lamp projector module swivels, all other lamps remain 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 .



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 bulkhead in the passenger compartment, 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 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.

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 LH steering column multifunction switch.

The headlamp delay is activated when the lighting control switch is in one of the 3 exit delay positions 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 or 120 seconds. After the delay period, the CJB automatically switches off the delay function, extinguishing the headlamps.

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

AUTOMATIC HEADLAMP OPERATION

The automatic headlamp function is a driver assistance system. The driver can override the system operation by selection of side lamp or headlamp on if the ambient light conditions require front and rear lighting to be active. The automatic headlamp system uses a light sensor and the CJB , which are connected via a LIN bus 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.

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 automatic headlamp operation uses ambient light levels which are monitored by photodiode incorporated in the rain/light sensor. The rain/light sensor sends a lights on/off request to the CJB on 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 multistoried car parks.

Operation of the automatic headlamps requires the ignition to be in ignition mode 6, the lighting control switch to be in the 'AUTO' position and a lights on request signal from the light sensor. If the rain sensor signal activates the fast speed wipers, the low beam headlamps are activated, providing the lighting control switch is in the 'AUTO' position.

If the automatic headlamp function has been selected and the ambient light falls below a pre-defined level then the 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 automatically activated, but the rear fog lamps, which were previously manually selected, will not.

AUTO HIGH BEAM (AHB)

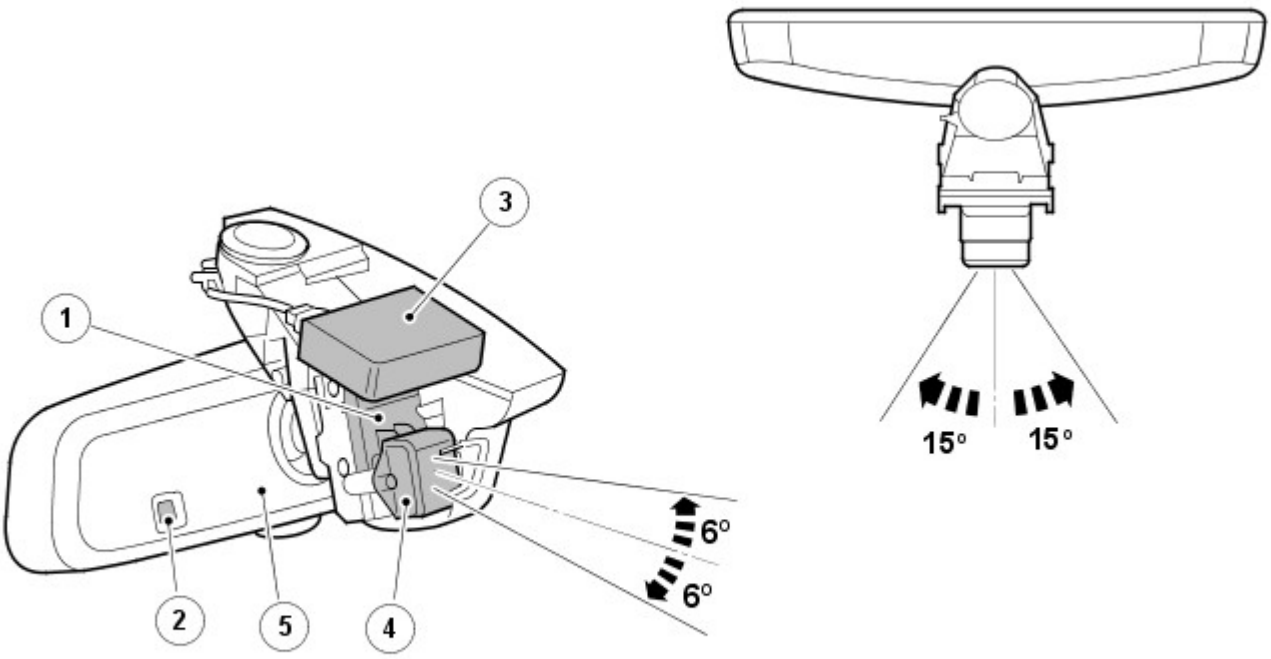
The automatic headlamp system has an additional feature called Auto High Beam (AHB). AHB is an automatic driving aid that relieves the driver of having to switch the high beam lighting on and off.

The AHB functions by employing a light sensor and a camera (image) sensor which together monitor ambient light levels, oncoming vehicle headlamps and preceding vehicle tail lamps. The rain/light sensor (integrated unit) and the camera (image) sensor are located in the interior mirror mounting behind an aperture and looking forwards through the windscreen. If required the system can be overridden.

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.

The AHB system is controlled by an AHB control module, which is located in the interior rear view mirror body, and by CJB . The module and the CJB are connected via the medium speed CAN bus.

Auto High Beam Interior Mirror



E117701

Item	Description
1	Rear view mirror calibration bracket
2	Ambient light sensor (HBA)
3	Rain/light sensor (Auto headlamps)
4	Image sensor
5	AHB control module (inside mirror body)

High Beam Assist Warning Indicator

E117699

The warning indicator for the AHB system is green and illuminates if the high beam is activated by the AHB system. The blue high beam warning indicator will also illuminate.

NOTE: The function of the normal 'blue' high beam warning indicator remains unchanged and it always reflects the actual status of the high beam lamps

Auto High Beam Operation

The AHB 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 AHB will automatically operate the high beam lighting when necessary. A warning symbol in the instrument cluster confirms to the driver when the AHB system is selected and enabled.

NOTE: 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 AHB 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)

AHB 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:

- AHB 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, AHB 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, AHB 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 AHB 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 ABS (anti-lock brake system) 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 AHB system at any time. When the AHB 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 AHB 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 AHB warning indicator will illuminate again.

Correct Performance

In addition, AHB 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
- The AHB 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 AHB feature must first be enabled using the configuration menu available in the instrument cluster. However if required, the AHB 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 Auto High Beam 'Enable'

To set the AHB options the following steps must be sequenced:

- With the ignition in power mode 6 (ignition on), and the engine not running, use the joypad controls on the steering wheel to select on the instrument cluster menu:
  - Menu > Vehicle Set-up > Auto High Beam
- 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 Auto high Beam' 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 'Auto High Beam 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.

Refer to: Instrument Cluster (413-01 Instrument Cluster, Description and Operation).

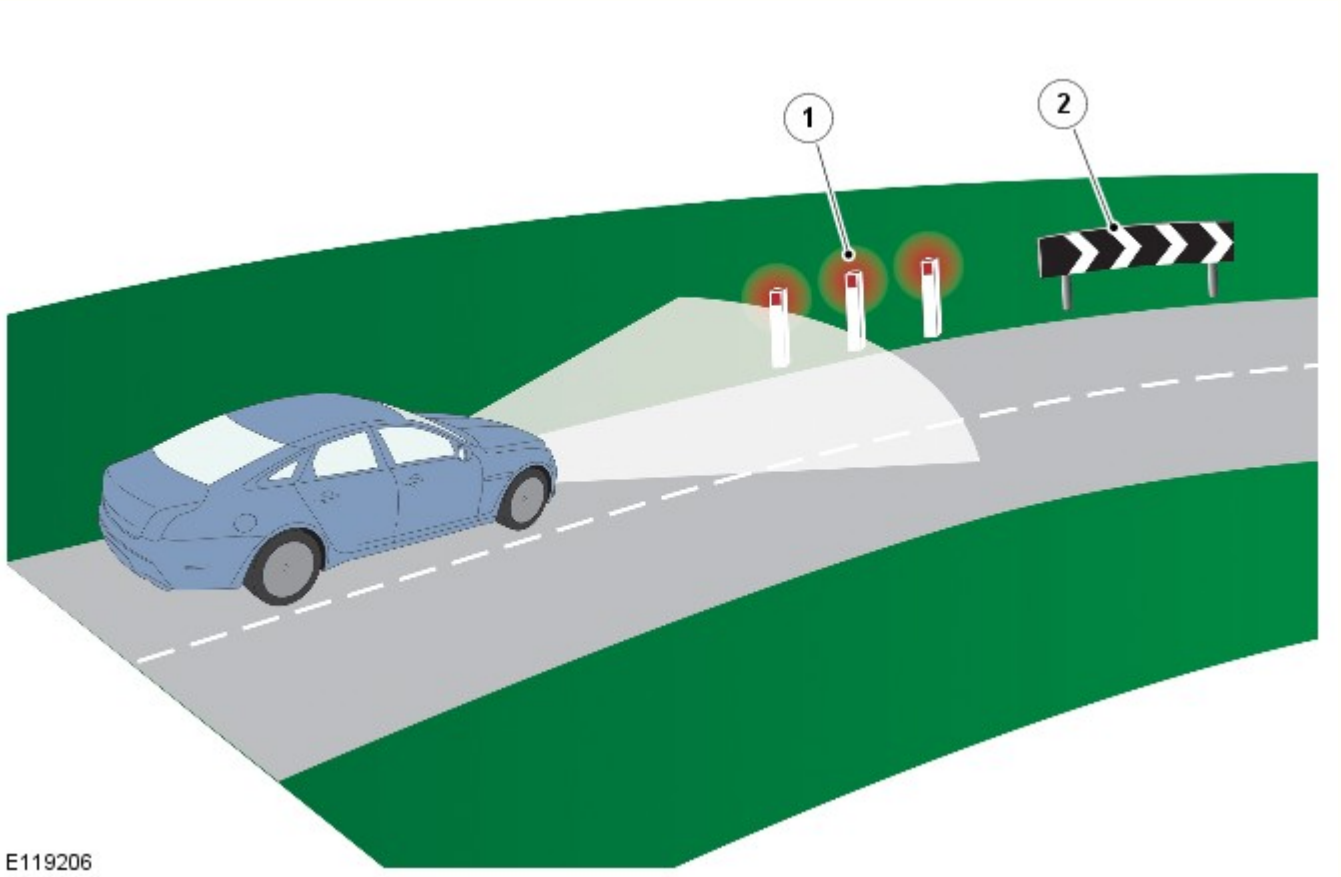
System Limitations

The AHB 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 AHB 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

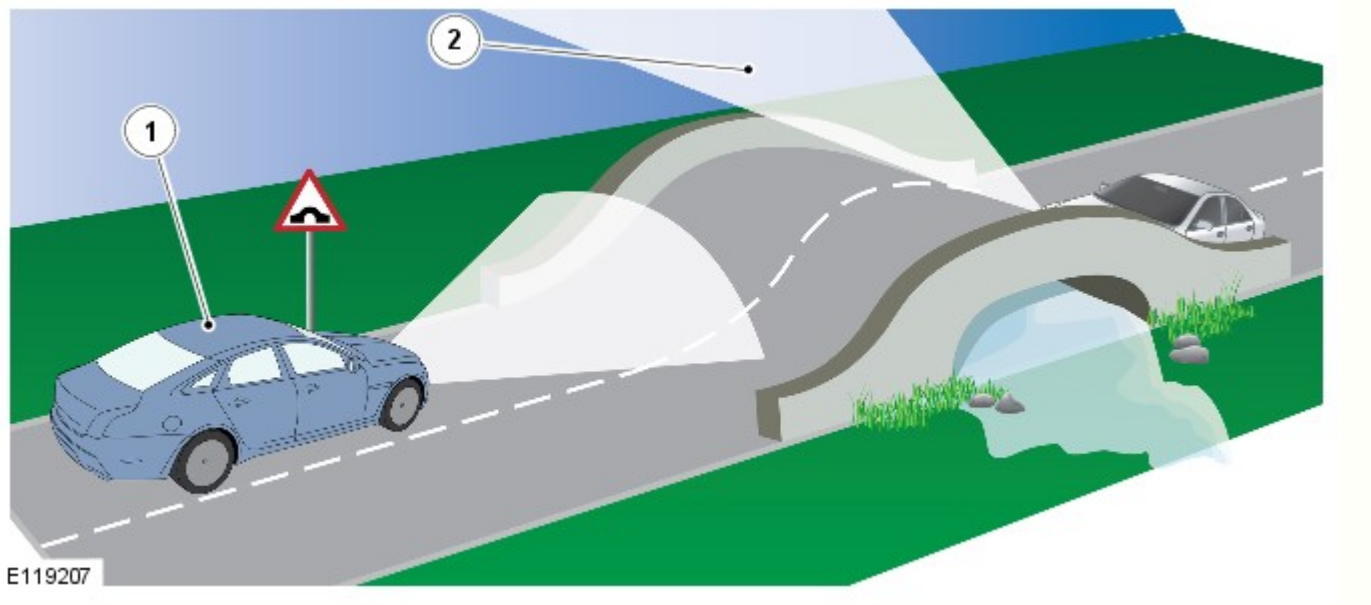
Reflective Static Signs



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

There are typical examples when a driver is able to judge if a manual high beam deactivation is necessary before the system operates automatically, for example over the crest of a small bridge. Lights from an oncoming vehicle can be seen on the horizon prior to the camera (image) sensor receiving an input. Although the other road user is approaching the high beam light source, it is not yet affecting the occupants in this situation. Manual override in this instance would be possible although not necessary as the AHB will turn off the high beam lamps upon receiving the input to the camera (image) sensor.

Manual Deactivation



Item	Description
1	Vehicle equipped with auto high beam
2	Oncoming lighting can be seen prior to auto high beam image sensor receiving an input

There are situations when a driver is able to judge if a high beam deactivation is desirable before the AHB 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.

Auto high beam 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. DTC 's are stored in the AHB control module's memory and can be accessed using an approved Jaguar 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 "Camera Blocked" message within the message centre

System Calibration

To achieve effective operation of the AHB 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 AHB 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.

DAYTIME RUNNING LAMPS (DRL)

Refer to DRL section for details.
Refer to: Daytime Running Lamps (DRL) (417-04 Daytime Running Lamps (DRL), Description and Operation).

REAR LAMP ASSEMBLY

The rear lamp assembly is located in the rear quarter panel. The rear lamp assembly is located in a recess in the vehicle body and is secured with 3 studs on the lamp body which are secured to the vehicle body with 3 flanged nuts.

All rear lamps use lamps use LED 's with light guides which use internal refraction within the light guide to distribute the light.

E126906

Item	Description
1	Side marker LED
2	Direction indicator LED's
3	Reverse lamp LED's
4	Rear fog lamp LED's

5	Reflector
6	Stop/side lamp LED's
7	Attachment studs (3 off)
8	Electrical connector

Rear Stop and Side Lamp

The side lamps and stop lamps use 36 LED 's. The 36 LED 's are illuminated at a higher intensity than the side lamp when the stop lamp switch is operated by pressing the brake pedal.

A side marker lamp is fitted to the outer rear lamp assembly and is fitted in all markets. The side marker lamp also uses 4 LED 's and are active at all times when the side lamps are selected on.

The stop lamps can also be activated by the adaptive speed control system. A signal from the adaptive speed control module is sent via the high speed CAN bus to the CJB which activates the stop lamps until an off message is received.

Turn Signal Indicator

The turn signal indicator lamp uses 12 amber LED 's which illuminate through a clear lens.

Reverse Lamp

The reverse lamp uses 2 LED 's which illuminate through a clear lens.

The reverse lamps are activated on receipt of a reverse selected message sent on the medium speed CAN bus to the CJB .

Rear Fog Lamp

The rear fog lamps each use 3 high intensity LED 's. The rear fog lamp is activated using a button located on the auxiliary lighting switch in the instrument panel.

LICENCE PLATE LAMPS

Two licence plate lamps are located in the rear bumper. Each lamp can be removed by inserting a wide, flat screwdriver blade or similar tool in a slot between the lamp lens and the finisher and gently levering the lamp from the surround. The 5W bulb is a push fit in a holder which in turn is a press fit in the lamp housing.

HIGH MOUNTED STOP LAMP

The high mounted stop lamp is located at the bottom of the rear windshield. The lamp is secured to a bezel in the parcel shelf with 2 screws.

The high mounted stop lamp uses 12, red colored LED 's which illuminate through a clear lens. The high mounted stop lamp functionality is the same as that described for the stop lamps.

TURN SIGNAL INDICATOR SIDE REPEATER LAMPS

The turn signal indicator side repeaters are located in each door mirror. The lamp uses a 5W orange bulb. The lamp unit is secured to the mirror bezel with 2 screws and is connected to the mirror wiring harness with a 2 pin connector.

The side repeaters have the same functionality and operate in conjunction with the front and rear turn signal indicators and the hazard warning flashers.

HAZARD FLASHERS

The hazard flashers are activated by a non-latching switch located in the switch pack located in the center of the instrument panel. The hazard flashers operate at all times when selected and operate independent of the ignition mode.

When the hazard flashers are selected on by the driver, a ground path is momentarily completed to the CJB which activates the front and rear and side repeater turn signal indicators. A second press of the switch is sensed by the CJB and the hazard flasher are deactivated. When the hazard flashers are active, they override any request for turn signal indicator operation.

The hazard flashers can also be activated by a crash signal from the RCM .
Refer to: Air Bag and Safety Belt Pretensioner Supplemental Restraint System (SRS) (501-20B Supplemental Restraint System, Description and Operation).