LED Lighting Systems

The purpose of this section is to give the delegates a clear understanding of the LED headlamp system used on the F-PACE. We will be discussing the exterior lighting options available on the vehicle and will look closely at the LED headlamp architecture as used on the high level models. Delegates will be able to identify the correct diagnostic procedures for LED headlamps and obtain expected values that can be used back at work.

NOTE: There are no internal replaceable parts in an LED headlamp; the headlamp must be replaced as a complete assembly. Always ensure that all functionality is tested correctly before replacing any parts or assemblies.

There are three headlamp options, split into two categories as follows:

- **Mid/Low**
  This refers to the Halogen and Xenon headlamps, which have one sealed access cover and a sealed bulb holder.
- **High Level**
  This refers to the LED headlamps, which have no access covers or replaceable parts.

F-PACE Headlamp Options

E180580

Item	Description	Item	Description
1	Halogen Headlamp	3	LED Headlamp
2	Xenon Headlamp		

Halogen Headlamp
Halogen projector lamp with double roundel design. The inboard roundel combines the direction indicator, Daytime Running Lamp (DRL) and side lamp functions. The headlamp design includes a chrome signature J-Blade trim (unlit).

Xenon Headlamp
Bi-Xenon projector headlamp with double roundel design and Light Emitting Diode (LED) J-Blade signature Daytime Running Lamp. The inner roundel houses the direction indicator. The Xenon headlamps will be fitted in conjunction with headlamp wash and automatic headlamp leveling.

LED Headlamp
Multi-zone LED reflectors provide all forward lighting functions. The upper zone provides low beam and Adaptive Front lighting System (AFS) lamps, which swivel with driver steering input. The lower zone provides high beam and static cornering lamp. The LED Daytime Running Lamp (DRL), side lamp and direction indicator are all combined into the J-Blade.

The F-PACE is also fitted with front LED fog lamps, which are integrated into the front bumper (model and market dependent). The front fog lamps are switched via the front fog lamp relay, controlled by the BCM/GWM.

F-PACE Front Fog Lamps

Item	Description
1	LED Front Fog lamps

NOTE: The F-PACE is the first Jaguar vehicle to use both front and rear LED fog lamps.

LED Headlamps are available on high-specification vehicles and offer the following advantages:

- Reduced parasitic loss – approximately 6% improvement
- Lowers CO_2 emissions
- Greater light intensity
- Smaller components, allowing manufacturers more flexibility when designing light units

The LED headlamp assembly has additional functionality that enhances the driver's vision when driving in the dark:

- Automatic Headlamp Leveling
- Static Bending Lamps (not NAS)
- Adaptive Front Lighting System (AFS)

Operational Requirements

Daytime Running Lamps (DRL)

In order for the DRL to operate the vehicle must have the ignition on with the engine running. When the vehicle is initially started, the DRL will not illuminate until the vehicle is taken out of park. If the vehicle is placed back into park the DRL will stay illuminated.

Static Bending Lamps

The vehicle must have the engine running and be in Drive. The vehicle must also see a speed input and a steering input before the bending lamps will illuminate.

NOTE: The Static Bending Lamps are fitted and operational in Jaguar vehicles, but currently disabled in NAS market vehicles.

Adaptive Front Lighting System (AFS)

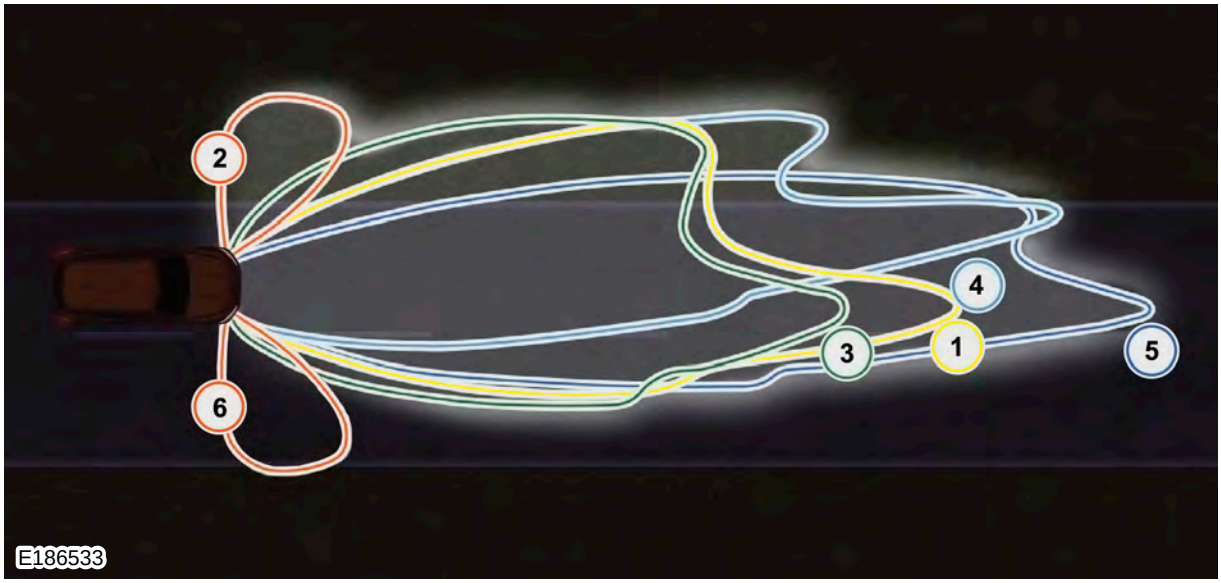
The vehicle must have the engine running and be in Drive. The vehicle must also see a speed input and a steering input before the AFS will operate.

NOTE: In markets with DRL, the AFS system will not operate when the DRL are active.

The purpose of these driver aids is to enhance driver visibility through all road conditions. They ensure that the headlamp beam is always pointing in the correct direction and height level regardless of cornering angle or vehicle luggage weight.

E181310 shows the different lighting patterns available on the F-PACE with LED headlamps.

LED Headlamp Beam Patterns (Right Hand Drive shown)



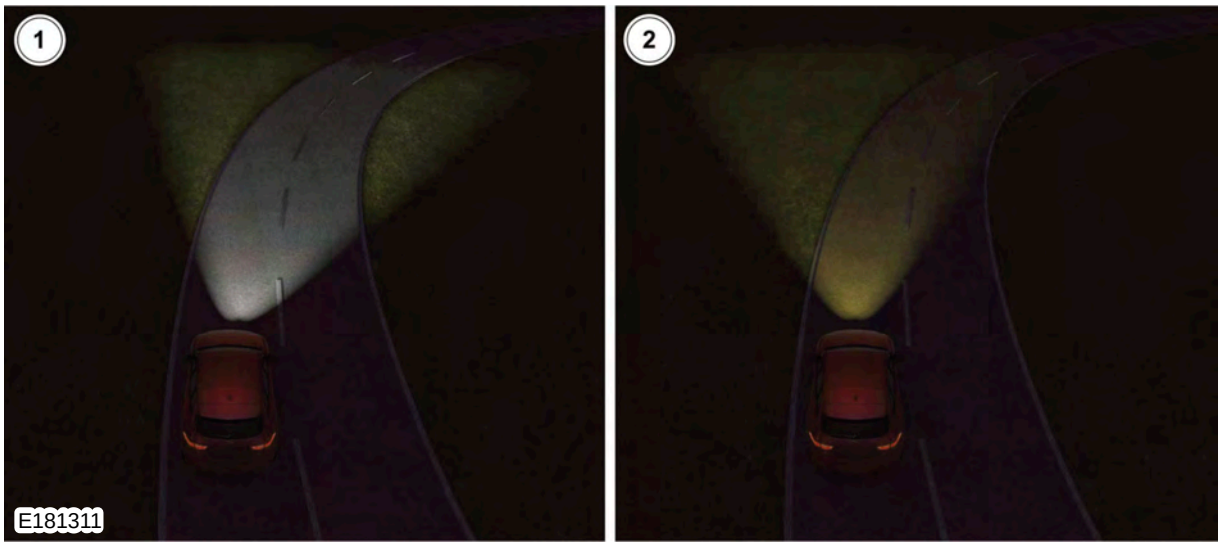
Item	Description	Item	Description
1	Urban lighting	4	AFS headlamps
2	Static bending lighting	5	Automatic low/high beam assist
3	Fog lighting	6	Static bending lighting

In order for these additional systems to work there must be communication between other systems such as:

- Steering angle sensor
- Vehicle speed information from the ABS control module
- Suspension height sensors

The combined Body Control Module and Gateway Module (BCM/GWM) communicates with the additional systems via high speed CAN. This combined unit is responsible for supplying the fused feeds to the lighting units and also for receiving the hardwired inputs from switches such as the Brake Lamp Switch and the Hazard Warning Switch.

Adaptive Front Lighting System



Item	Description
1	LED Headlamps with Adaptive Front Lighting System (AFS)
2	Halogen Headlamps without Adaptive Front Lighting System (AFS)

At speeds greater than 0 mph (0 km/h), the LED headlamps will adapt to the driver inputs. All horizontal movement is achieved without any vertical deviation (less than 0.2%). The system achieves a maximum of 15° horizontal swivel of the module.

The Static Bending Lamps (SBL) operate at speeds up to 43 mph (70 km/h) to illuminate the road or driveway to assist the driver. This operation requires the transmission in 'D' and a steering input to function.

The AFS system will only operate between a set speed range, therefore it requires a vehicle speed signal from the ABS Control Module. The speed and steering angle signals are transmitted via high speed CAN to the BCM/GWM, which then controls the angle of movement via a LIN signal to the headlamp unit.

NOTE: Both Static Bending Lamps and AFS are disabled if the vehicle is in reverse.

The actuators do not supply a positional feedback signal to the BCM/GWM. Each stepper motor requires referencing each time the AFS system becomes active when the ignition is turned on. When the AFS system is active, 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 BCM/GWM is set to zero and the actuator is then powered to the operating position as determined by the AFS software.

Adaptive Front Lighting System (AFS) Warning Lamp

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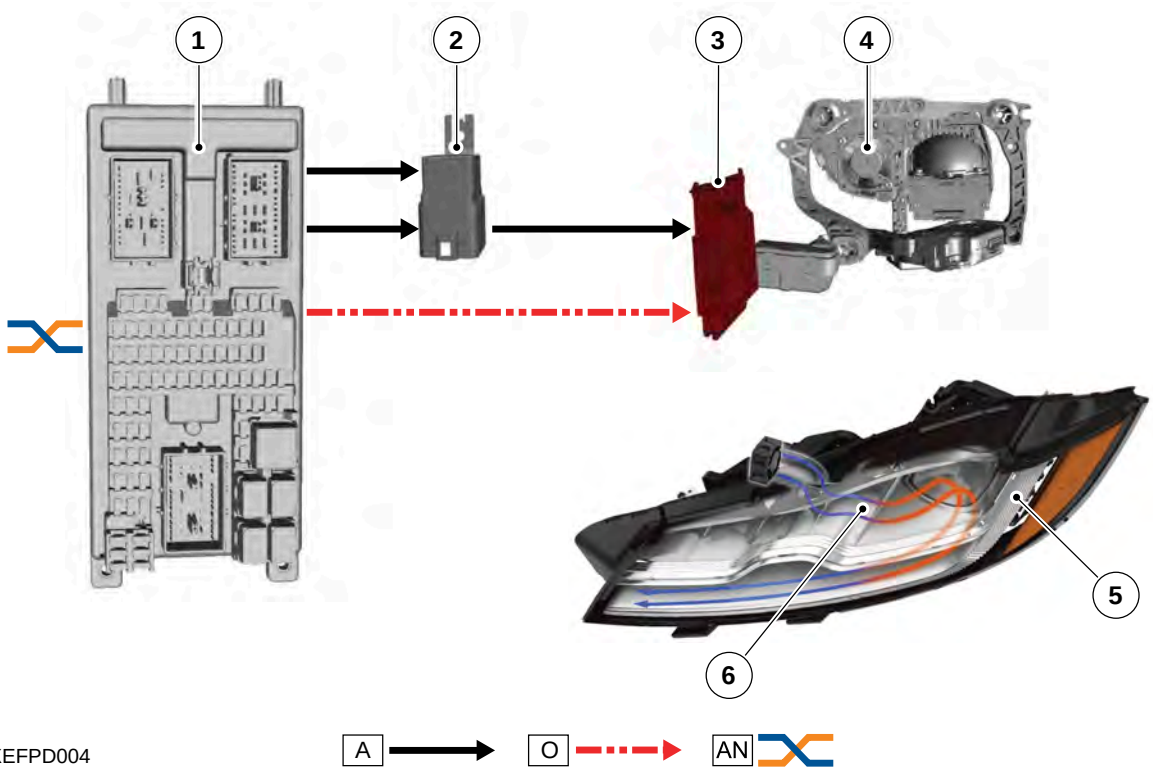
Light Emitting Diode Driver Modules

The headlamp assemblies contain a Light Emitting Diode Driver Module (LEDDM). Each module receives a power supply from a headlamp relay which are located beneath the Right headlamp. The relay output and the relay control coils are hardwired to the CJB, two independently fused circuits supply power for the relay outputs.

To protect the LED lights and the LEDDM from overheating a cooling system is installed within the headlamp assembly. A cooling fan, controlled and powered by the LEDDM provides a flow of air inside the assembly to maintain their temperature, as a benefit the circulating warm air is directed to the headlamp cover to provide a demisting or de-icing function.

The CJB communicates with both the LEDDM's using the LIN Bus 5 connection. Vehicle information is sent on the LIN Bus to activate various lighting functions.



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Item	Description	Item	Description
A	Hardwired	3	Light Emitting Diode Driver Module (LEDDM)
O	LIN Bus (5)	4	Cooling fan
AN	CAN Bus	5	Headlamp Assembly
1	Central Junction Box (CJB)	6	Air flow
2	Relay		

Temperature Management

In contrast to Halogen or Xenon systems, LEDs emit ‘cold’ light, meaning that no infrared rediation is being produced. Due to the high efficiency, 20% of the input energy is transformed into visible light; for comparison, a filament bulb only transforms 5%, The rest of the energy generates heat within the semiconductor chip.

Luminous flux, color, and forward voltage are dependent on the temperature. As soon as the allowed temperature is exceeded, the lifetime of the LED will be badly affected or in the worst case will be destroyed. To protect the chip, which is the hottest part, cooling elements with a controlled air transportation system have been developed. The systematic direction of the warm air to the bezel of the headlamp is simultaneously used for de-icing and de-condensation.

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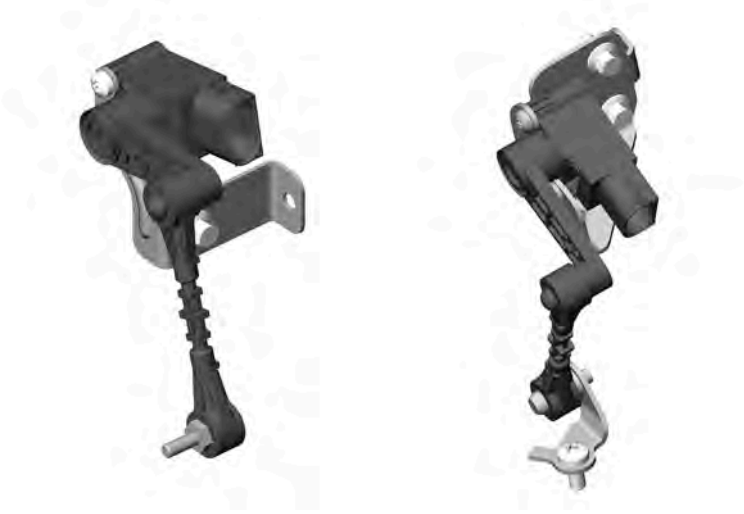
Reduction of Energy Consumption

The application of LED technology significantly contributes to reduced CO_2 emissions and fuel consumption. The use of LED Daytime Running Lamps (DRL) also makes an important contribution to a proper energy balance, since 75% of all driving in the world takes place during the daytime. In specific terms, DRLs with LED technology consume 14W (with 0.36g of CO_2/km) per vehicle. When regular low beams are used, energy consumption is approximately 300W (with 7.86g of CO_2/km) – 20 times greater than LED DRLs.

Automatic Headlamp Leveling

The F-PACE has Automatic Headlamp Leveling. This is achieved using two height sensors, fitted to the right front and right rear suspension. Both sensors are connected directly to the BCM/GWM, which provides the sensors a 5V supply and ground. The sensors' signal wire is also connected directly to the BCM/GWM.



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Leveling sensor operating voltages

- As the vehicle load increases the sensor output decreases.
- An unladen vehicle will produce approximately 3.5V from both level sensors.

On startup, the headlamp leveling motors will not move unless there has been a change in the vehicle load since the last ignition cycle. No motor test is carried out.

The headlamp level will not adjust immediately after a suspension movement; a delay is built into the system to account for braking, accelerating, and bumps in the road.

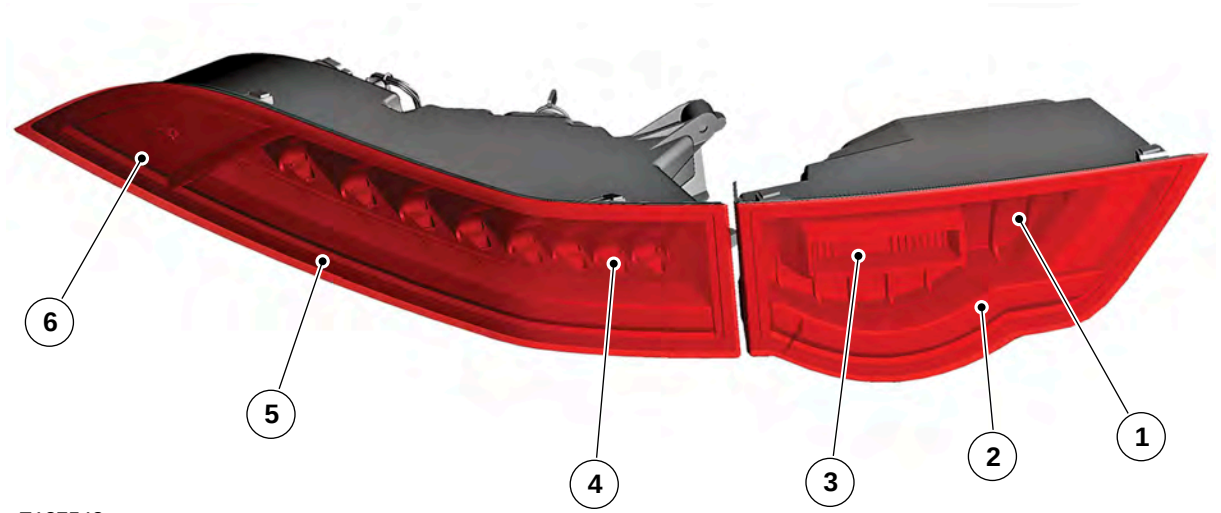
Rear Lighting

The rear lights are of a similar design to the F-TYPE. On all variants, all rear lamp functions use LED lighting, including the reverse lamps. F-PACE has two rear fog lamps.

The tail lamp assembly is a two-piece unit. The outer assembly is fixed to the body of the vehicle; the inner assembly is fixed to the tailgate.

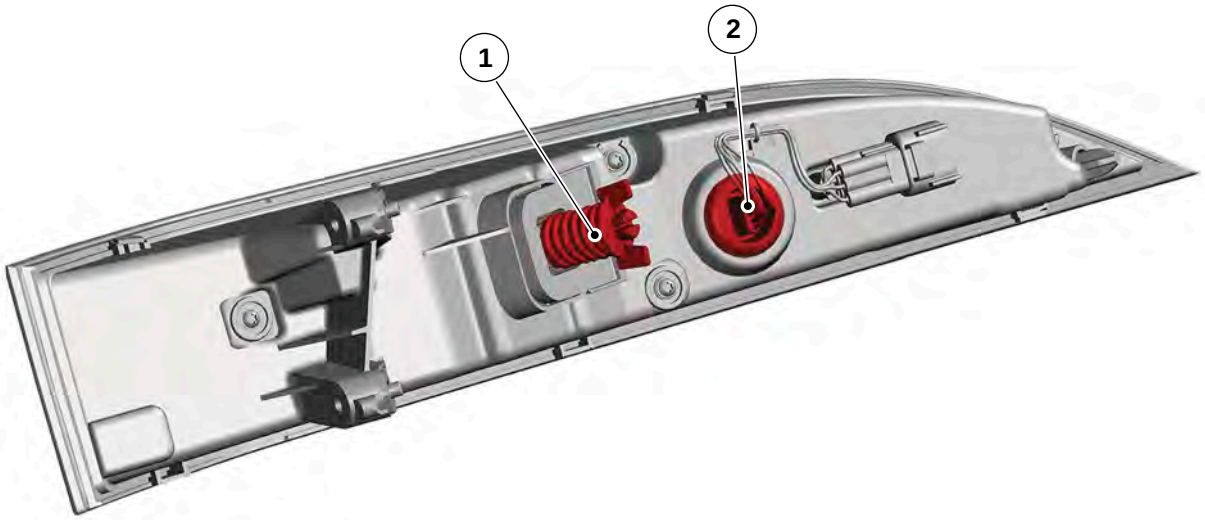
The tail lamp assemblies have the following functions:

- Outer tail lamp assembly – tail light/direction indicator and stop lamp
- Inner tail lamp assembly – tail light and reverse lamp



Item	Description	Item	Description
1	Reflector	4	Brake lamp
2	Inner tail lamp	5	Tail light and direction indicator light guide
3	Reverse lamp	6	Side marker

The outer tail lamp assemblies are secured to the body by a sprung mounting screw. This allows for quick and easy removal of the body-mounted lamp assembly. The mounting screw is accessed through the rear interior trim access panel located at each rear corner of the vehicle. There is one electrical connector, which must be disconnected before the tail lamp can be removed.



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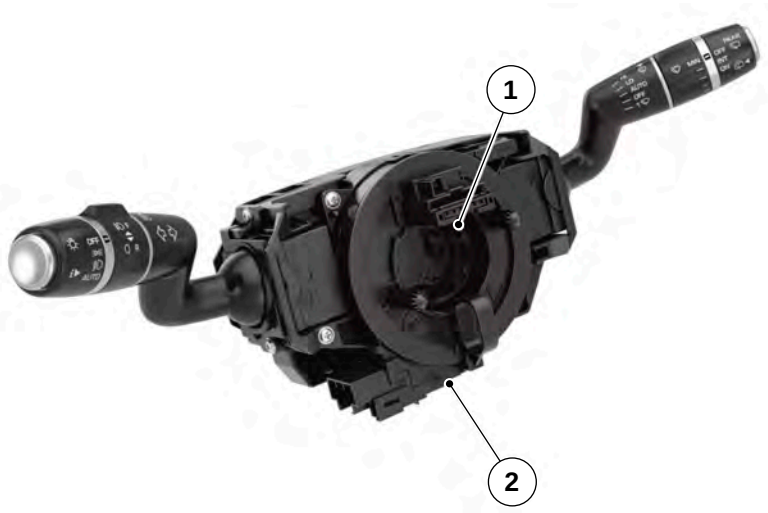
Item	Description	Item	Description
1	Tail Lamp Mounting Screw	2	Tail Lamp Harness

The inner tail lamp assembly is secured to the tailgate by three nuts, which can be accessed via the rear tailgate trim.

Components

Lighting Control Switch

Standard light functions are controlled by the Lighting Control Switch at the steering column. This unit also houses the Clockspring, Steering Angle Sensor, and Steering Wheel Module. Lighting inputs (except hazard warning lamps) are sent to the BCM/GWM by LIN via the Steering Wheel Module.



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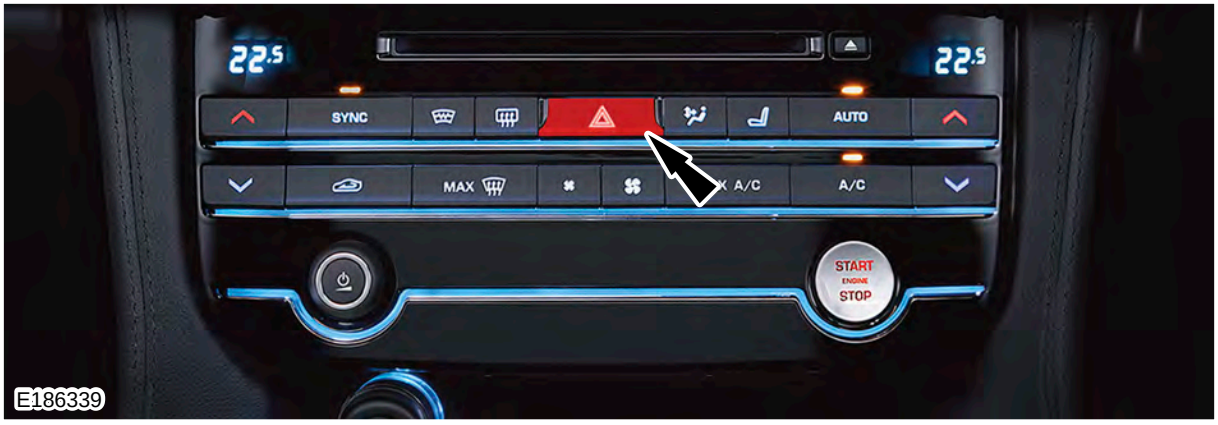
Item	Description	Item	Description
1	Steering Angle Sensor	2	Steering Wheel Module

Hazard Warning Switch

The hazard warning switch is hardwired into the BCM/GWM, which supplies the normally open switch with a voltage. When pressed, the switch grounds the BCM/GWM, which in turn switches on the hazard warning lamps. The switch will also supply a power feed when the hazard warning lamps are on to illuminate the switch button.



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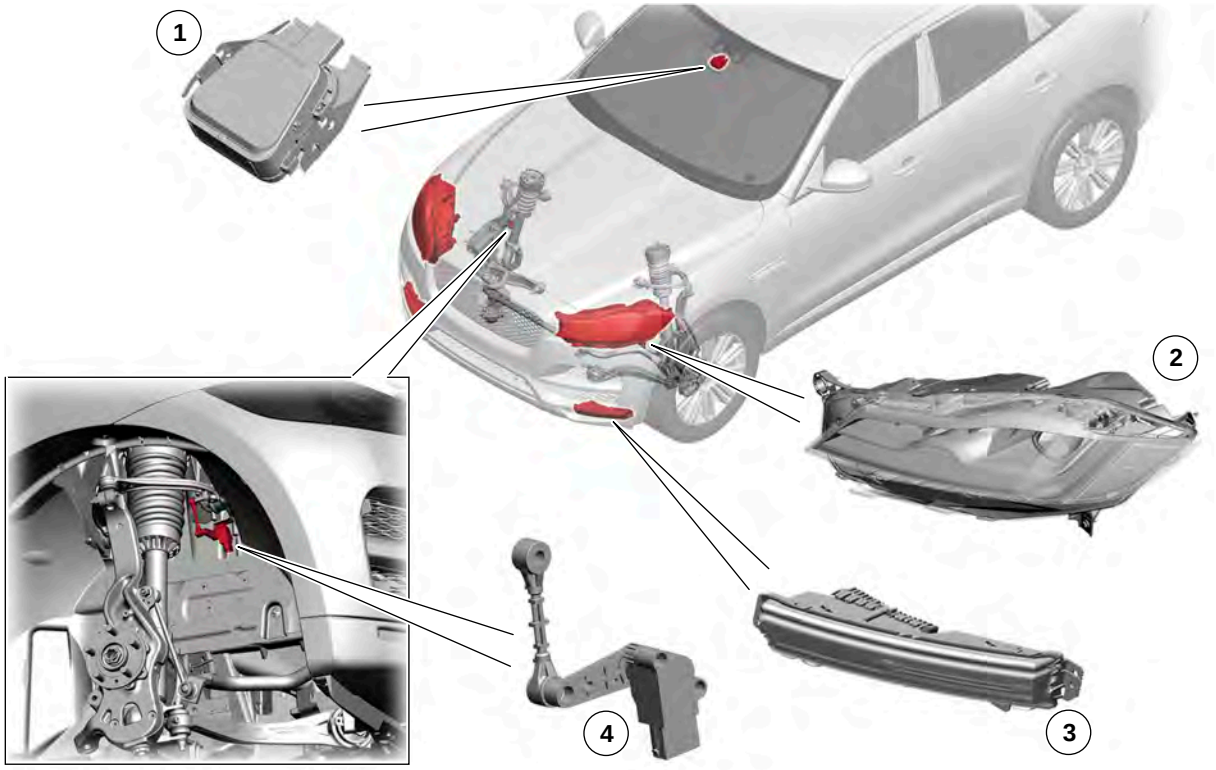
Component Locations

The following graphics show the lighting components and associated sensors required for all driver aids to function.

Lighting Components – Part 1



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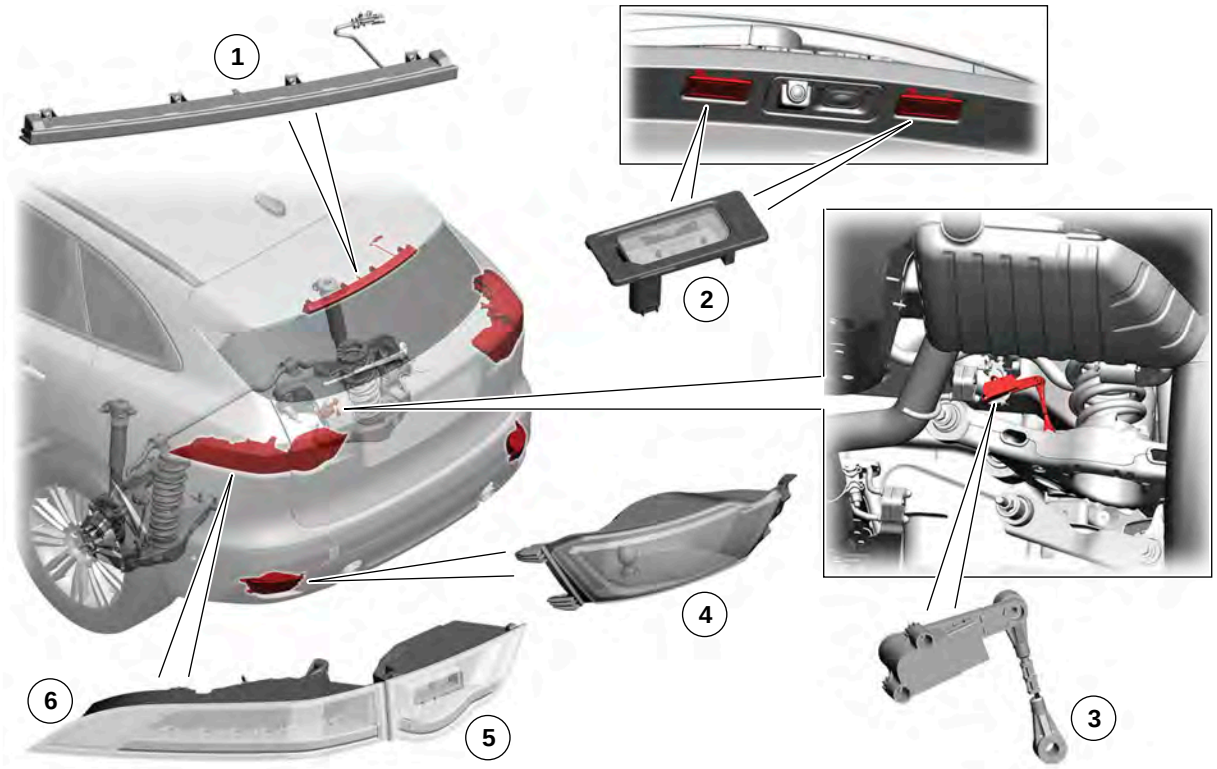
Item	Description	Item	Description
1	Rain/Light Sensor	3	Front fog lamp
2	Headlamp assembly (LED shown)	4	Front right height sensor (LED headlamps only)

Lighting Components – Part 2



E186397

Item	Description	Item	Description
1	High Mounted Stop Lamp	4	Rear fog lamp assembly
2	License Plate Lamps	5	Tail lamp assembly – inner
3	Rear height sensor (Xenon and LED headlamps only)	6	Tail lamp assembly – outer