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E65 VEHICLE LIGHTING SYSTEMS

Model: E65 - 745i

Production Date: 11/2001 - Start of Production

Objectives:

After completing this module you should be able to:

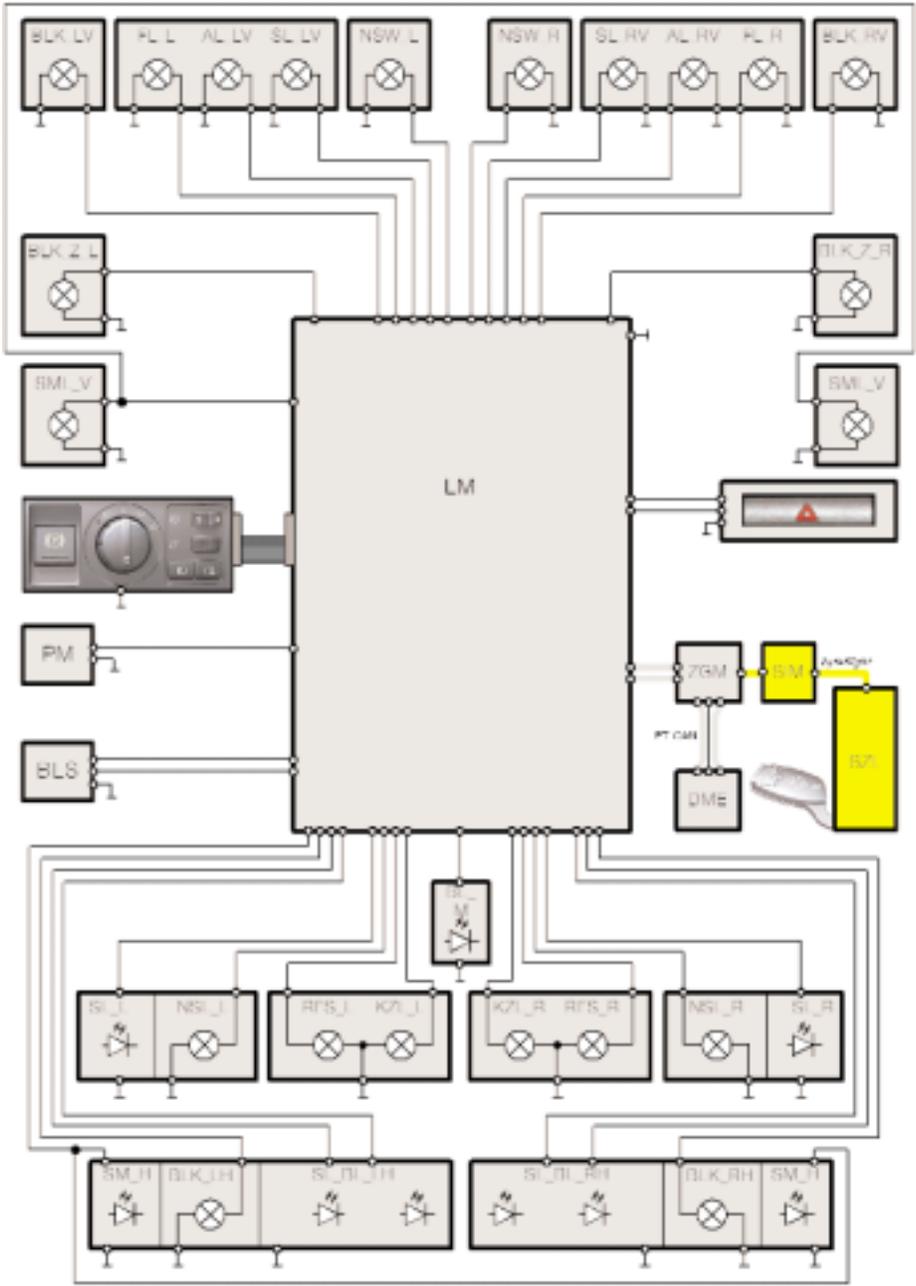
- Understand which components control the different lighting circuits of the E65.
- Explain the function and operation of Automatic Driving Light Control (FLC).
- Understand the operation of the bi-xenon lights.

Introduction

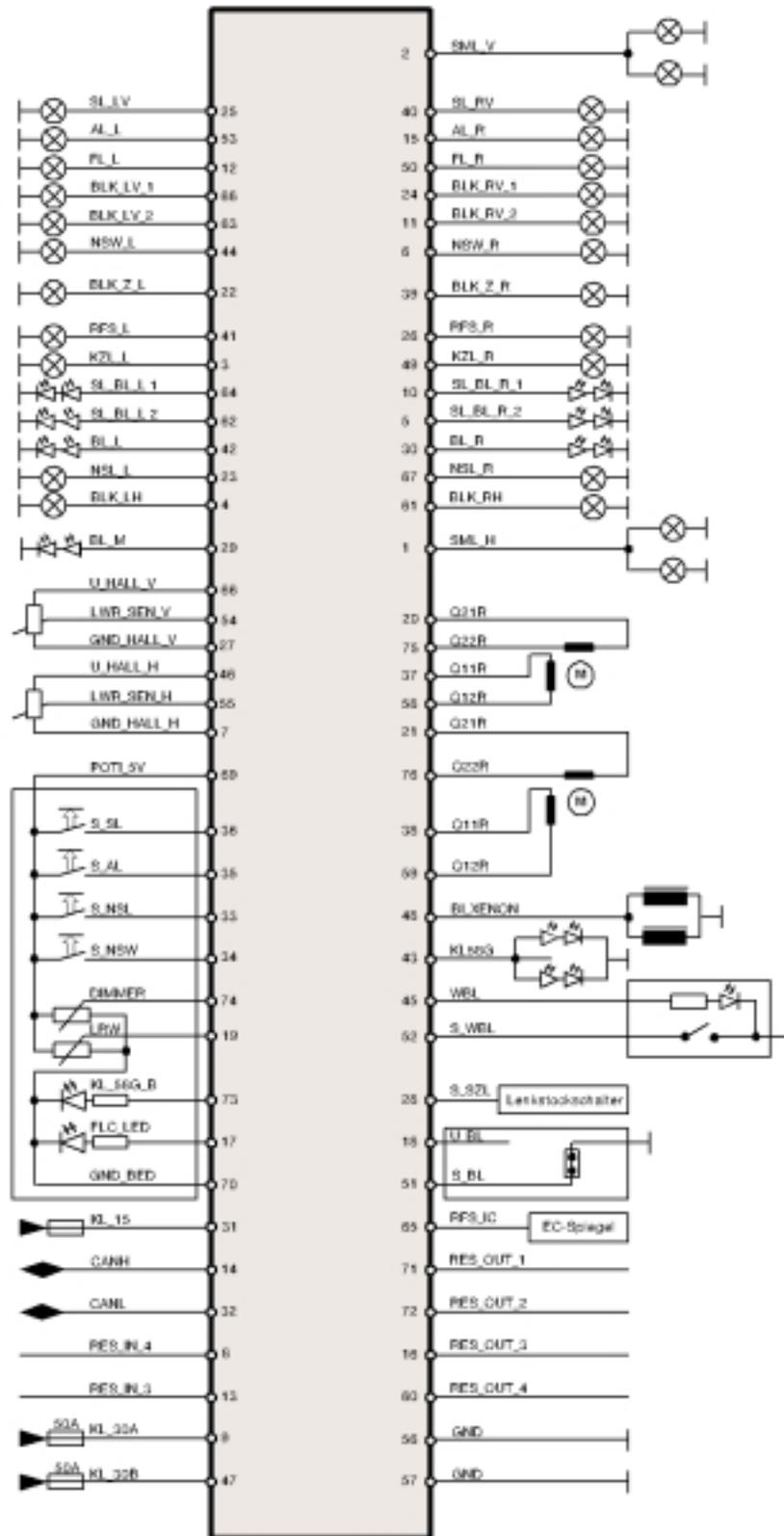
The vehicle lighting is split into exterior and interior lights. The exterior lights are controlled by the Light module. The interior lights, in contrast, are controlled by the Power Module.

EXTERNAL LIGHTING

System Overview



I.P.O



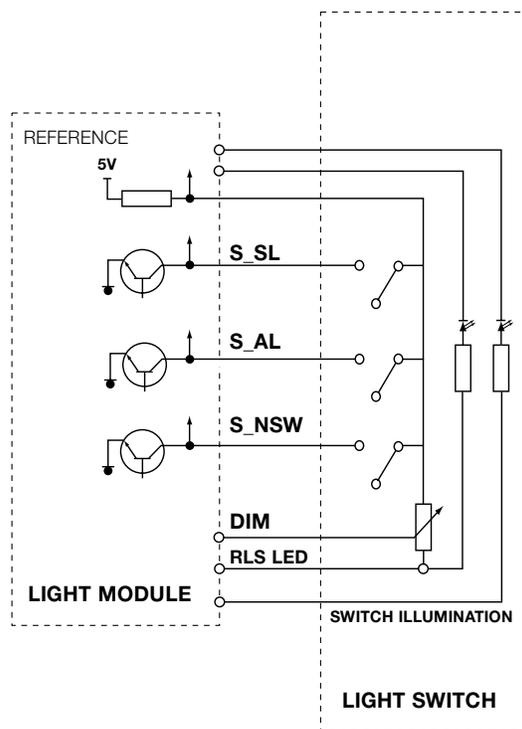
Light Switch

The light switch is located to the left of the steering column. It is a single component and includes the following controls:

- Rotary knob light switch (including Automatic position).
- Fog light push button.
- Dimmer potentiometer thumb wheel.
- Button for EMF (parking brake).
- Button for opening trunk (TOEHKI).



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The switches for trunk opening and EMF are interpreted separately by their respective control units.

The light switch uses a 5 volt reference supplied by the LM and provides the position of the rotary knob light switch over two wires.

When the switch is open, the LM reads 5V. When the switch is closed, the LM reads 2.5V. A value of over 6.75 volts represents a fault and activates the emergency operation of the LM.

Interpretation of the 4 light switch positions is based on the switch logic over the two wires.

	S_SL	S_AL	S_NSW
Switch position: Automatic	1	0	-
Switch position: OFF	1	1	-
Switch position: Parking lights	0	1	-
Switch position: headlights ON	0	0	-
Foglight ON (lights must be on)	-	-	1
Foglight OFF	-	-	0
Failsafe	0	0	

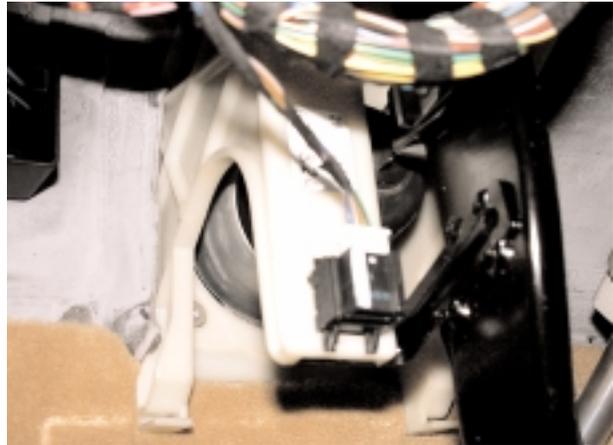
1=switch closed
0=switch open

The foglight switch is similarly interpreted as a high low signal over its own wire.

Brake Light Switch

Similar to previous models an electronic brake-light switch (Hall-sensor) is used. It is powered from KL R ON. Its signal is provided as an analog input.

The brake switch has a level of 0 volts in the non-actuated state and approx. 8 - 9 volts when the brake is depressed (dependent on the system voltage).



Fault Detection

There are two different fault scenarios for the brake-light switch: short circuit to ground and open circuit.

Short circuits to ground can only be safely detected with terminal R OFF. If a low level is detected instead of the anticipated high, there is a short circuit and the brake-light switch is determined to be faulty. This self-diagnosis is only performed after entry into power-down mode so long as no light function is activated while the K-CAN-S bus is inactive.

A possible open circuit is not electrically distinguishable from an actuated brake. With terminal 15 ON and information on brake pressure (DSC - PT-CAN - ZGM - K-CAN-S - LM) but no detected brake-light-switch actuation, the brake-light switch is also condemned as faulty. The fault entry "Brake-light switch faulty" is made in both cases.

Limp-Home Functions

The function of the brake light is assured even when the LM is in limp-home mode. Internal circuitry connects the brake-light-switch output directly to the lamp drivers. The function rules out the possibility of PWM operation.

Hazard-Warning Button

The hazard-warning button has a level of approx. 4.7 volts in the "hazard-warning button not pressed" state and 0 volts in the "hazard-warning button pressed" state.

The hazard-warning button is located in the IHKA control panel and is a direct input to the LM.

Steering Column Turn Signal and High Beam Stalk

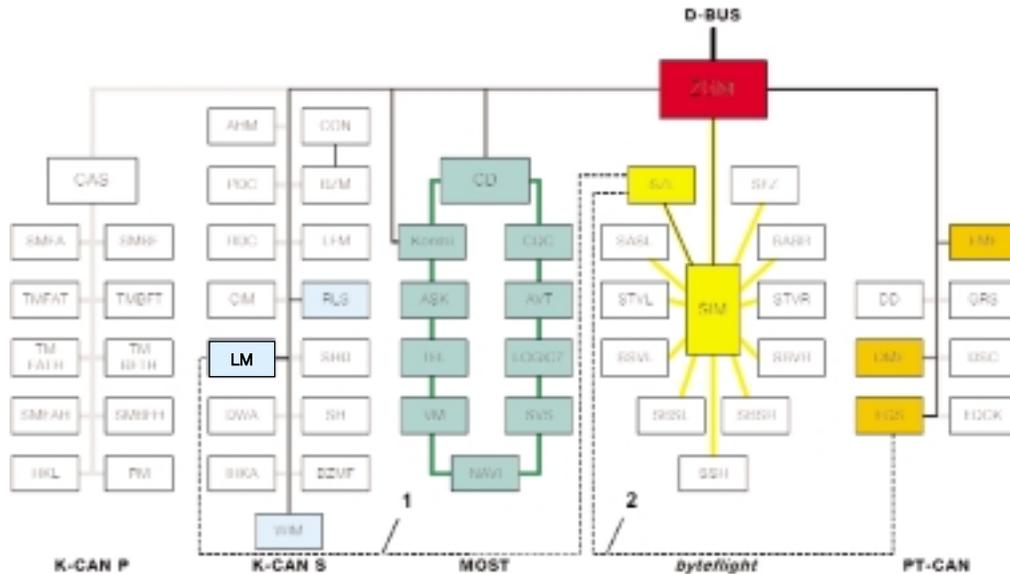
Driver request signals from the steering column stalk are received by the LM as K-CAN-S messages. In the event of a bus fault, the signals are interpreted as analog values over a separate input line. The following functions are evaluated as CAN messages:



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- 1) Single-touch flashing, left or right
- 2) Continuous flashing, left or right
- 3) High beam on
- 4) High beam off or headlight flasher

The command for cancelling of the turn signals comes from the steering angle sensor of the SZL.



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Fault Detection

If no K-CAN messages are received from the steering-column stalk for a period exceeding 20s, the stalk is determined to be faulty. K-CAN communication continues to be attempted, although the light functions are then determined by the analog data line input. The fault status is terminated by newly detected K-CAN communication.

The following functions are determined as analog values over the data line in the event of a fault:

- 1) High mode on/off or headlight flasher
- 2) One-touch flashing, left/right
- 3) Neutral position

Rain/Light Sensor

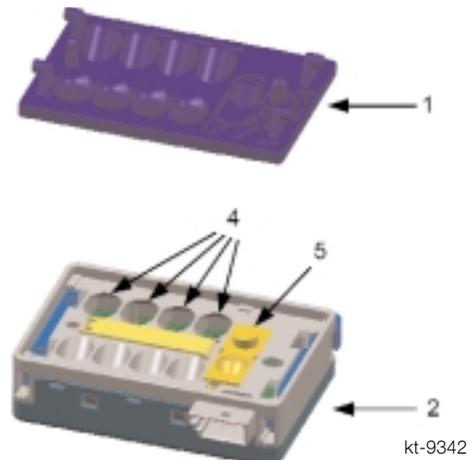
The Rain/Light Sensor is attached to the windshield. It records:

- The rain intensity for controlling the wiper intervals
- The surrounding and frontal brightness for controlling "automatic-light control"

2 additional optical sensors are evaluated in the RLS.

If there is a switch-on requirement, this is transmitted by a K-CAN message to the Light Module.

If the rotary knob light switch is in the "automatic light control" position, the headlights lights are activated and an LED on the light switch is switched on.

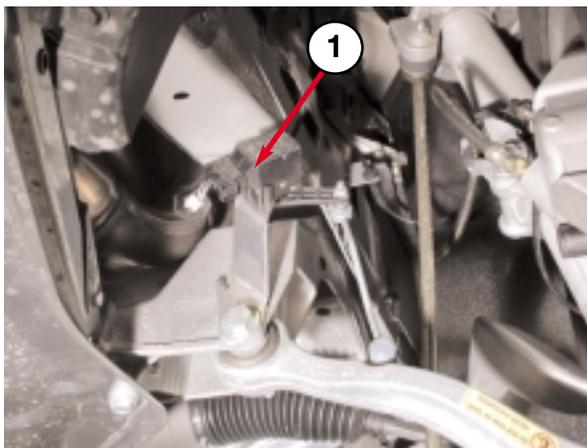


LWR Ride Height Level Sensors

The E65 headlight system also includes headlight vertical aim control (LWR). This system is very similar to the LRA function incorporated into the LSZ of the E46.

The servo-motor for control of vertical adjustment of the headlight is controlled directly by the Light Module.

Similar to the E38, angle-hall sensors (1) used to detect changes in vehicle loading are mounted on the front and rear right side axles.



Exterior Lighting Components

The external lighting system consists of the following components:

- Front headlight assemblies (parking, Low beam, high beam, turn indicators)
- Fog lights
- Tail light assemblies (tail light, brake lights, turn indicators, reverse lights and license plate lights)

Front Headlight Assemblies

The new headlights with integral turn indicators are in the BMW tradition of being four round lights. The turn signal indicators are now above the lights, giving them the appearance of “eye brows”.

The E65 is equipped with new “Bi-Xenon” lamps as standard equipment. The inboard lamps are conventional halogen bulbs.



A sidemarker (U.S. version) is integrated into the turn signal indicator.



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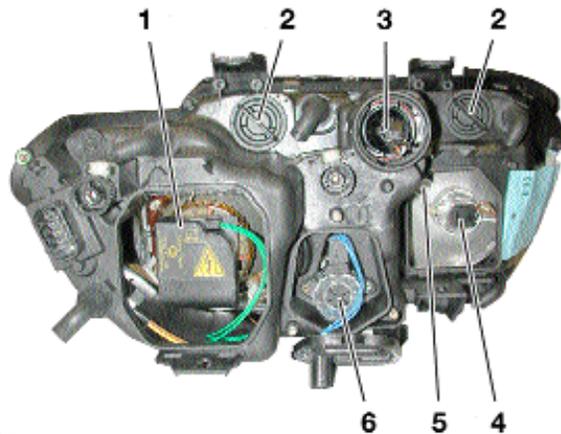
- 1. Xenon bulb**
- 2. Control unit for xenon light (Hella 4th generation)**

The parking light is an optical-wave guide ring around each high-beam and low-beam headlight, similar to the 2001 E39.

The headlight assemblies are a sealed integral unit. The replacement of the bi-xenon bulb and the control unit require that the headlight assembly be removed from the vehicle.

All other bulbs can be replaced without removing the headlights.

In order to remove the front headlight assemblies, the front bumper must first be removed.

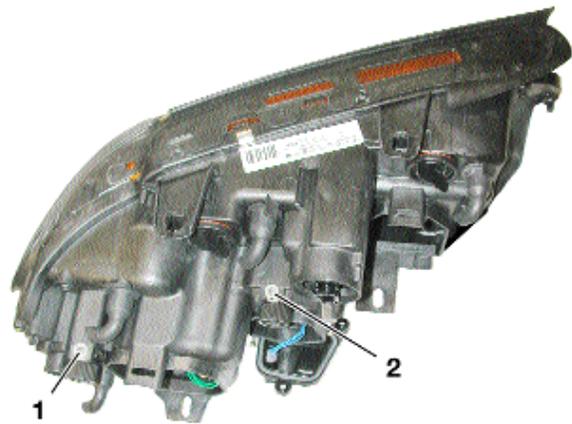


1. Bi-xenon low beam and shutter mechanism
2. Turn signal bulb
3. Light source for parking light rings
4. High beam, halogen bulb
5. Not used
6. Servomotor for LWR (Headlight vertical aim control)

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There are holes for easy access to the screws for height adjustment and lateral adjustment of the low-beam and high-beam headlights.

The outer adjusting screw (1) is for lateral adjustment of both lights. The inner adjusting screw (2) is for vertical adjustment of the high-beam and low-beam headlights.

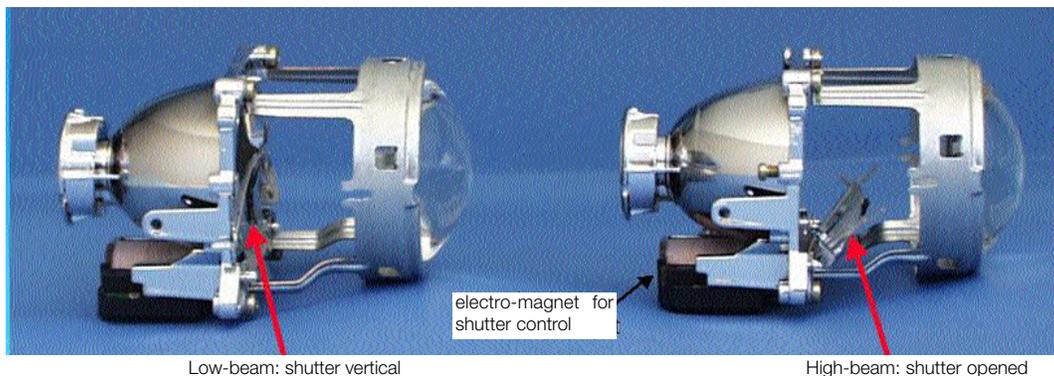


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Bi-Xenon Lights

“Bi-xenon” means that the xenon lights can be switched over from low-beam to high-beam.

When the low beams are “on”, the lower part of the light beam is blocked by a shutter that is directly in front of the reflector.



When high beams are switched “on”, an electro-magnet is energized by the LM. The electro-magnet “flips” the shutter open, allowing the entire beam of light generated by the xenon bulb to be part of the high-beam.

Fog Lights

The fog lights of the E65 are small ellipsoid lights similar to the E39.

A single screw secures each fog light in position. The snap-fit horizontal grille insert has to be removed in order to gain access to this screw. The screw for vertical adjustment is freely accessible. The fog light has to be removed in order for the bulb to be replaced.



Tail Light Assemblies



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1. Location of mounting screw
2. Adjusting screw



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The rear light assemblies are integrated into the rear quarter panels and into the luggage compartment lid.

The tail light, brake light and turn indicator lights are located in the rear quarter panels.

An additional tail light is integrated into the luggage compartment lid, along with the rear fog light, reverse light and license plate light.

Tail lights and brake lights are 3D brilliant type (light sources are LED illuminated).

The third brake light below the rear shelf is also an LED assembly that can only be replaced as a complete unit.



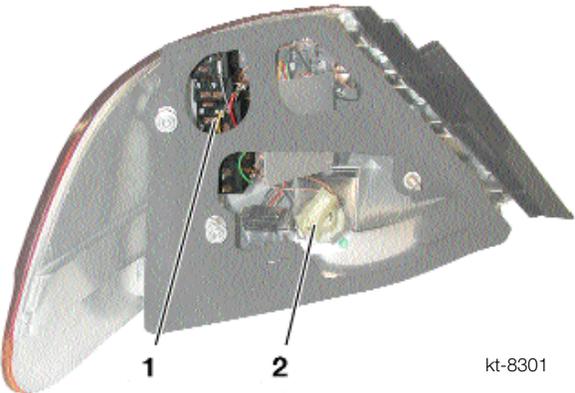
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1. Tail light
2. Brake light
3. Direction Indicator
4. Tail light
5. Rear fog light
6. Reverse Light

Incandescent bulbs are used for the turn indicators (2). The brake lights and tail lights are lit by LEDs.

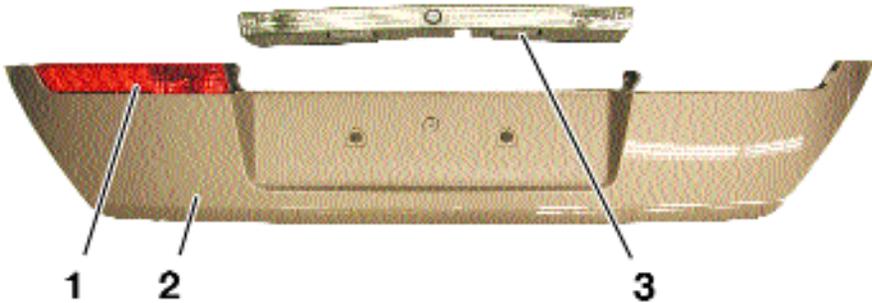
In the U.S. version, the tail lights light up along with the brake lights when the brakes are applied.

If a tail light or brake light fails, the entire rear light assembly has to be removed so that the LED controller (1) can be replaced.



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A three-part light assembly is integrated into the luggage compartment lid.



- 1. Tail light/rear fog light
- 2. Plastic rear trim panel
- 3. Center light group: Reverse lights and license plate lights

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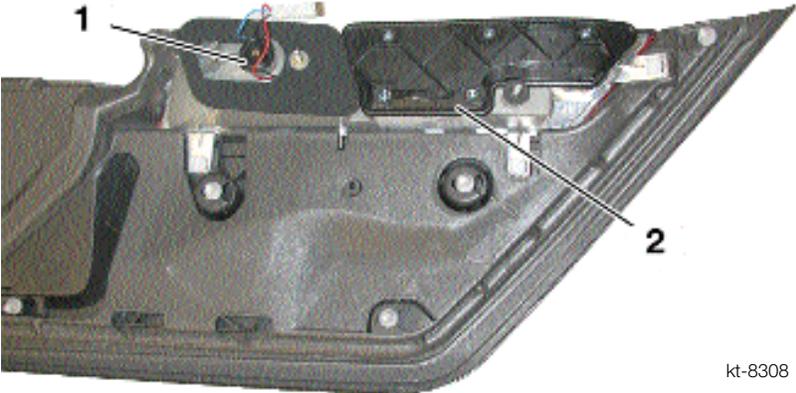
These three lights are secured to the rear lid trim panel on the luggage compartment lid by screws.

There is a non-reflective design area between the two reversing lights.

The reverse lights, the rear fog lights and the license plate lights all have incandescent bulbs, whereas the tail lights, like those in the side panels, are LED lights.

The interior trim of the luggage compartment lid behind the light clusters has to be removed to replace the bulbs.

- 1. Bulb for rear fog light
- 2. LED controller for tail light



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Principle of Operation

The following tasks are performed by the Light Module (LM):

- Control and monitoring exterior vehicle headlights and lamps.
- Function of dimmer for instrument and control panel lighting (KL 58 g).
- Automatic Driving-Light Control (FLC).
- Control of the headlight-vertical aim control system (LWR) with dynamic control.
- Internal power management (sleep mode)
- Emergency functions.
- Redundant data storage

Lamp Control and Monitoring

Power Limitation

In order to increase their service life, the incandescent vehicle lamps are activated using PWM once the system voltage rises above a coded value.

Any further increase in the system voltage results in constant voltage operation not to exceed 13.5 volts.

Dynamic PWM correction

The short-term peak loads of the Valvetronic unit create voltage dips in the vehicle electrical system, which in turn can result in fluctuations in the vehicle lighting. In order to reduce this effect, the LM incorporates adapted measures which compensate for this by performing a fast PWM correction.

Bulb Monitoring

All bulbs with the exception of the LED brake/tail lights and the xenon headlights are cold monitored. The LEDs and bi-xenon lights are warm monitored along with the rest of the bulbs.

The LM signals the instrument cluster if a bulb has failed so that it can display a Check Control warning to the driver.

See the E65 Instrument Cluster module of the iDrive chapter for detailed descriptions of the CC warning messages.

Brake Force Display

As an indication of heavy vehicle braking or when the ABS is in regulation, the tail lights mounted on the luggage compartment lid illuminate at the same intensity as the brake lights.

It is activated by the LM recognizing a rapid change in acceleration and ABS operation.



Regular brake display



Heavy braking display

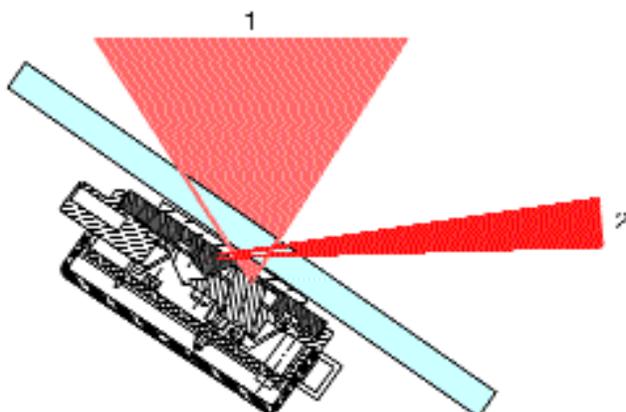
Automatic Driving Light Control (FLC)

Automatic Driving Light Control is a new function that is controlled by the LM.

In order to operate the system, the rotary knob light switch must be placed in the automatic position. An LED illuminates on the switch to indicate that the system is on.



The Rain/Light Sensor detects the surrounding and frontal brightness using two photo-transistors.



1, The surrounding-light sensor records the light intensity in a wide angle above the vehicle.

2, The frontal-light sensor records the light intensity in a narrow angle in front of the vehicle.

An internal processor calculates from the measured data if a switch-on situation is needed. The following switch-on situations can be detected:

- Dawn/dusk
- Darkness
- Driving into an underground car park
- Driving through a tunnel
- Precipitation such as rain or snow

If a switch-on situation is needed, this is communicated to the Light Module (via the K-CAN-S bus).

Headlight Vertical Aim Control (LWR)

Headlight Vertical Aim control is used to adapt the position of the headlights automatically to the vehicle load condition.

Headlight Vertical Aim Control has the following features:

- 1 stepper motor for each left and right headlight assembly.
- Activation of stepper motors in parallel on left and right sides (common driver IC).
- Possibility of diagnosing missing connections to stepper motors (line break) and short circuits in windings (motor fault).

Referencing of Stepper Motors

The position of the stepper motors is initially uncertain after LWR is activated. First of all, a reference run is carried out which takes place in two phases for the purpose of improving accuracy. The object of the reference run is to guarantee a fixed initial position (calibration) for the headlights.

Automatic Setpoint Generation

Automatic LWR derives the setpoint for the headlight range from two ride-level sensors. These sensors are mounted on the front and rear axles. They are used to determine the difference in ride height between the front and rear axles.

The input signals (0.3 - 4.7 V) of the ride-level sensors are measured with the engine running or lights ON cyclically at intervals of 20 ms. Voltage values < 0.3 V and > 4.7 V are interpreted as faults. The LM registers a fault entry "Sensor, ride level, front, faulty" or "Sensor, ride level, rear, faulty".

Dynamic Headlight Vertical Aim Control

The effect of dynamic LWR, is that the headlight aim is corrected immediately in critical driving situations (extreme braking; heavy acceleration).

In this way, reduced headlight aim under certain circumstances (e.g. during braking) is immediately corrected by the process of the head lights being "raised".

Also, the dazzling of other road users is eliminated during acceleration by the process of the headlights being "lowered".

The problem of incorrect interpretations (e.g. irregular road surface) is avoided by the use of more signals than just the ride-level signals.

It can usually be assumed that a braking operation is always accompanied by a simultaneously actuated brake-light switch. However, the brake-light switch is not actuated during acceleration. The vehicle speed is included in the correction calculation.

Dynamic Compensation During Braking: Because of the "system knowledge" that compensation of the headlight aim during braking is particularly more important when braking at high speeds, dynamic LWR can dampen compensation of the headlight aim at low speeds.

Dynamic compensation during braking begins "gradually" above the minimum speed of approx. 40 km/h (25mph) and reaches its full effect from a speed of approx. 80 km/h (50mph).

As long as the brake light switch is not actuated, there is no dynamic compensation for braking.

Dynamic Compensation During Acceleration: Acceleration is more "probable" the lower the initial speed is. Absolute accelerating performance decreases as speed increases because the vehicle is being driven in higher gears and therefore less torque is available.

Complete dynamic compensation takes place during acceleration as long as the speed is less than approx. 50 km/h (31mph). The effect of dynamic compensation decreases increasingly above this speed and disappears from a speed of approx. 110 km/h (68mph).

When the brake light switch is actuated, there is no dynamic compensation for acceleration.

Activation of Stepper Motors

Functions of the software driver for activating the stepper motors:

- Positioning of stepping motors (powering, acceleration and deceleration).
- Carrying out a reference run (each time LWR is activated).
- Inclusion of current actual step counter.
- Setpoint/actual-value comparison of step position.
- Activation of stepping-motor driver.

Internal Power Management (Sleep Mode)

Because the LM's operating current consumption would place unwanted load on the vehicle battery during long periods of parking and when its functions are not needed, it is provided with mechanisms for identifying out-of-service periods and reducing the power requirement while retaining wake-up readiness.

The micro-processor of the LM functions with nominal operating current when:

- The CAN is active.
- Terminal R (input) is active.
- Terminal 15 (input) is active.
- Lamp functions are active.
- Anti-theft alarm-system alarm is active.
- The follow-me-home light circuit is active.

If none of the above conditions apply, the LM transmits its sleep readiness and then switches into sleep mode. It also switches into this mode when the sleep conditions are in place and the sleep acknowledge bit has been received from another bus user.

After approx. 30 s the current consumption drops from approx. 120 mA to below 1 mA. The LM awakens cyclically and input signals are monitored so that the system can respond to possible changes in the switch states and the external inputs.

A CAN telegram received during this power-saving mode results in system wake-up. Following a wake-up period of max. 100 ms, the LM is again ready for communication, relevant telegrams are fully received and evaluated in each case so that no bus information is lost.

If no wake-up condition occurs for a period exceeding 390 s, the switch inputs are no longer monitored and the zero-signal current is reduced further.

System wake-up is possible by CAN telegrams, an activated terminal 15 or the hazard-warning button.

Redundant Data Storage

The LM shares responsibility with the CAS for the storage of the Vehicle Identification Number and the FA (Vehicle Order).

Emergency Functions

The system is equipped with hardware that is completely independent from the processor in order to safeguard the functions needed for driving safety should the processor or one of its elements malfunction.

Emergency operation provides the following functions:

With terminal 15 ON, the following components are activated regardless of the position of the light switch:

- Low-beam headlights, left and right
- Rear lamps/brake lights, left and right (outer)

With terminal 15 ON and actuated brake-light switch:

- Brake lights, left and right

Turn-signal and hazard-warning flashers, high beam, headlight flasher, front fog lamps, rear fog light and the 3rd brake light cannot be activated. Communication via K-CAN-S is not possible.

System Overview Index

Index	Description	Index	Description
1	Footwell lamp	TMBFT	Door module, passenger door
2	Make-up light	TMBFTH	Door module, passenger door rear
3	Door exit light	TMFAT	Door module, driver's door
ZV	Central locking	TMFATH	Door module, driver's door rear
K-CAN-P	K-CAN Periphery	IB II	Interior lighting II
30	Terminal 30	PM	Power Module
58g	Terminal 58g		

Components

The interior lighting includes the following lights:

External Door Handle Lighting (Visual Entry Aid)

A "central light source" module with a lamp is located in each of the doors. With the aid of an optical fiber conductor, this module illuminates the entrance area of the vehicle and also lights up the exterior door handles.

The central light sources are controlled by the individual door modules.



The door modules communicate with the PM via the K-CAN-P for instructions when to activate and deactivate the light source module.

The CAS provides door opening, remote control operation and terminal status to both the PM and door modules.

Interior lights

A total of seven interior lights are provided: at the door entrance (all four doors), in the front right and left footwell as well as in the glove compartment.

The door entrance lights are controlled by the respective door modules. The footwell lighting is controlled by the IB circuit and the glove box light by the VA-K circuit of the Power Module.

Front Interior Light Roof Console

The interior light (2), two separately controlled reading lights on the right and left (3) as well as two LEDs for ambient lighting (1) are contained in the front light unit.

The interior light is controlled by the IB circuit and the reading lights are part of the VA-D circuit of the Power Module.

The contact for turning on and off the interior light is a momentary contact to the Power Module. The operation is the same as previous models including the “workshop mode” (hold for longer than 3 s, lights remain off).



The ambient lighting LEDs are supplied power by the KL-58g circuit of the Light Module.

Rear Interior Light Roof Console

An interior light roof console is also provided in the rear seating area.

It also contains an interior light, two separately controlled reading lamps on the right and left, a make-up mirror with two make-up lights as well as two LEDs for ambiance lighting.

The interior, reading and ambient lighting are controlled on the same circuits as the front with the exception of the lights for the make-up mirror which are controlled by the VA-K circuit.



Door Trim Panel Illumination

The grey decorative strip of the door trim panel also houses a fiber optic conductor that illuminates the inside door handle and switch blocks.

The light source is provided by a LED and controlled by the respective door module after receiving the KL58g signal over the K-CAN from the LM.

Interior Lighting Switching Criteria

Switch-On Criteria:

- Door open
- Terminal R off if KL 58g is active or has been active in the past 32 s.
- IB on by remote control (8 s search function).
- ZV unlocked by the crash sensor.
- ZV unlocked by remote control.
- By pulling on external door handle with terminal R off.

Switch-Off Criteria:

- All doors closed with terminal R or 15 on.
- All doors closed after 20 s switch-off delay with terminal R off.
- Terminal R off (if KL 58g has been active at least once inside the last 32 s) after 20 s switch-off delay.
- IB on by remote control (search function) after 8 s.
- IB on by remote control unlocking after 20 s.
- With door permanently open after 16 min.
- With all doors closed and ZV locked.
- Interior-light switch OFF.

Review Questions:

1. What is the communication path used to inform the Light Module of a turn signal request? How are the turn signals cancelled? _____

2. What is the difference between a xenon light and a bi-xenon light? _____

3. How is the FLC system activated? How is a switch on request received by the LM? _____

4. Which control unit controls the LWR function? What makes this a “Dynamic” system? _____

5. Describe the communication and control unit operation required to turn on the interior lights when unlocking the vehicle via the Remote Control. _____
