

Technical Information

Light – Headlamps



*Ideas today for
the cars of tomorrow*

Tasks of frontlighting

Headlamps illuminate the road space in front of the car and must meet the requirements of all road users. In particular, the low-beam functions are subject to legal regulations designed to protect oncoming traffic from being dazzled.

“Making the night into day” by maximizing the light output is therefore subject to reasonable restrictions. Only within the scope of legal regulations can danger situations in the case of poor visibility be gradually defused by improving many parameters of headlamp technology.

The following lighting functions can be combined in the headlamp:

Functions for seeing

1 Low beam is available as a series product in addition to the standard function, as an extended function of the **Variable Intelligent Lighting System** construction kit, called VARILIS®:

1a Static bend lighting as an additional low beam element

1b Dynamic bend lighting as swiveling low beam

1c Cornering light is a lamp function from the point of approval regulations, but is often integrated into the headlamp.

New lighting functions are ready for use in 2007.

2 High beam can also be designed in swiveling form as bend lighting, mainly in combined systems. To limit the maximal value on public road space, also in combination with auxiliary driving lamps, the legislator has defined a reference number. In the field of rally and off-road driving, those restrictions are not relevant. For that kind of application, performance is limited only by technical basic conditions such as package space, temperature and available light sources.

3 Front fog light is also used as an auxiliary lamp. Regulation R19 is presently being discussed and is to be adjusted to new technologies and market requirements.

Functions for being seen

4 Position light is often provided by a separate lamp located in the high beam reflector. However, the function also provides opportunities for unique styling elements or to introduce new technologies.

5 Daytime running light reduces the number of accidents and is now permitted throughout the world. If that function is specially designed, the additional power consumption remains low.

6 Direction indicator and **side marker light** can also be arranged inside the headlamp and are often used as special styling elements.



Auxiliary lamp



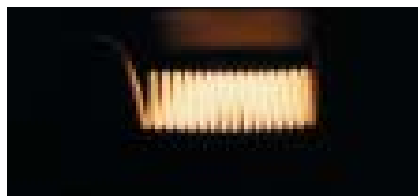
Main headlamp

Light sources

The basis of the headlamp light is the light source. Its geometry determines which optical systems can reasonably be used to distribute the luminous flux on the road space. Therefore, our specialists closely cooperate with specification committees worldwide even in the preliminary planning of new illuminant types and variants, thus contributing to the integral optimization of new lighting concepts.

Meanwhile, there are three families of illuminants for headlamps:

- **Filament bulbs**, mostly in the form of halogen bulbs, are widespread due to their relatively low price and continue to be commonly used. The objective of development is often the minimization of the tolerances for use in FF® systems.
- **Xenon bulbs** are available as D2 bulbs and as a D1 system with integrated ignition electronics. They require, at any rate, additional electronics.



Halogen H7



Xenon D2S

- **Light emitting diodes** have reached a sufficiently high luminance to make them suitable for headlamp functions. A summary on LEDs is provided on pages 8 and 9.

Halogen bulbs











	Lamps	Lighting function	Light source type	El. power, luminous flux
	H1	High beam Front fog light	Axial filament	55 W, 800 lm
	H3	High beam Front fog light	Transversal filament	55 W, 1,450 lm
	H4	Low beam + high beam	2 x axial filament	60 W/55 W 1,650 lm/1,000 lm
	H7	All headlamp lighting functions	Axial filament	50 W, 1,500 lm
	H8	Front fog light (possibly low beam)	Axial filament	35 W, 800 lm
	H9	High beam	Axial filament	65 W, 2,100 lm
	H11	All headlamp lighting functions	Axial filament	50 W, 1,350 lm
	HB3	High beam	Axial filament	60 W, 1,860 lm
	HB4	Low beam Front fog light	Axial filament	51 W, 1,095 lm
	NDF H13	Low beam High beam	2 x axial filament	75 W/68 W 1,700 lm/1,100 lm

Table of the most commonly used halogen bulbs

Xenon bulbs



D1/D3

D2/D4

- D2S Use in projector-type systems**
- D2R Use in reflection systems (shading paint on glass bulb)**
- D1S Use in projector-type systems (igniter integrated)**
- D1R Use in reflection systems (igniter integrated/shading paint on glass bulb)**

Compared to halogen bulbs, the Xenon bulb has the following advantages:

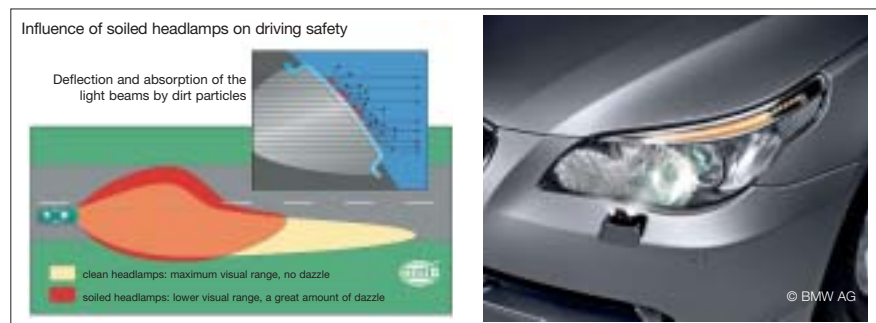
- Almost three times higher luminous flux (quantity of light/light output)
- High luminous efficacy (lighting efficiency)
- Considerably lower power consumption of 35 W
- Lower thermal stress on the system
- Considerably longer life
- The light color is almost that of daylight

Prescribed auxiliary systems in the vehicle

To avoid dangerous dazzling, the legislator has prescribed that the auxiliary systems “automatic headlamp leveling” and “headlamp power wash system” need to be installed if a certain lighting limit value is exceeded. For these systems, Hella offers different solution concepts and integration options.

Headlamp power wash system

Since 1972, Hella has been developing and supplying headlamp power wash systems which function based on the jet-water principle and clean the lenses without scratches. The nozzles may also be concealed. Their operating position is defined by our specialists in the laboratory and with the help of simulations. The highly standardized “headlamp power wash system construction kit” enables optimized solutions for almost any application with regard to functionality, costs and design.



Headlamp power wash system function



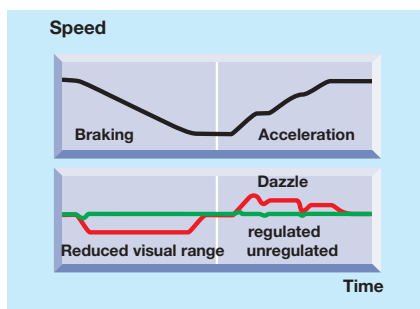
Components for dynamic headlamp leveling

Automatic headlamp leveling

The headlamp leveling devices mandatory in new cars with powerful headlamps since 1993 must function automatically. There are two performance levels:

1. Automatic headlamp leveling adjusts the inclination angle of the optical systems in the headlamp in such a way that the headlamp always remains in the prescribed and garage-adjusted base position irrespective of the state of load. An inductive axle sensor measures the spring deflection of the rear axle when the car is loaded and sends the data to the headlamp leveling control unit which controls a headlamp leveling actuator.

2. Dynamic headlamp leveling provides increased convenience. It also reacts to short-time inclination changes due to braking and acceleration processes. The inclination of the optical systems is thus adjusted even during driving. Usually, another vehicle level sensor at the front axle is used in combination with intelligent stepper motors.



Headlamps with and without dynamic headlamp leveling during braking and acceleration

Optical systems in the headlamp

The task of the optical system of a headlamp is to collect as much as possible of the luminous flux (quantity of light) emitted by the light source, to shape the beam of light and to direct it, within the bounds defined by the legal regulations, to the road-space areas where it is needed. Hella-made software for calculation of the optical systems enables the developer to make a comparative assessment of alternative solution approaches. The results of this simulation contribute to the decision for the concept which is best suited to package space, cost target and design.



Free-form reflector (FF®)

Different optical systems:

■ Paraboloid reflector

The light source is located near the focal point. The resulting beam path of the projected light is almost parallel. The light distribution is effected by optical elements in the cover lens.

■ Free-form reflector (FF®)

This reflector concept directly assigns an area of the road to be illuminated to an area in the reflector. The surface of the reflector is calculated with the help of a computer based on so-called deflection strategies. No regulating geometries result, but “free forms” (FF®). The Helios calculation software developed by HELLA is continuously extended for new FF® concepts.



Projection modules

■ Projector-type system

In this system, the reflector has no regulating geometry, but is a free-form system (FF®) which collects the light generated by the light source near a first focal plane. The light is then projected into a second focal plane in which a shield is located. The contour of the shield is then mapped to the road by a lens.



OPTIMO

The continuous further development of the projector-type systems by Hella has led to an extendable series of individual modules. With standardized interfaces to the headlamp, customers may come as close to their own lighting philosophy as budget and package space of the relevant project permit.

Even within a headlamp model range, differentiation is possible with simple means. In addition to the known HKM, the OPTIMO and HKMcompact model ranges are now available.

■ Bi-Xenon® and Bi-halogen

These types have a shield with a movable shutter. Thus the module can be switched from low beam to high beam.



Bi-halogen shield

Variable lighting system VARILIS®

On request, all projection modules can also be mounted as dynamic bend lighting in a projector group. This option is also being prepared for reflection systems. A separate Technical Information document is available on this. Likewise, extended light distributions can be realized in combination with individually adapted additional systems, for example, for static bend lighting.



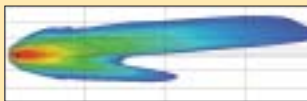
VARIOX® module



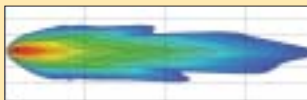
Town light



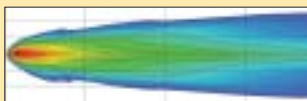
Country light ES



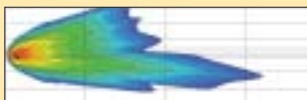
Country light LES



Motorway light



High beam



Adverse weather light

VARIOX®

The AFS law expected to become effective around the year 2007 will make driving-situation-dependent road illumination possible in addition to the current lighting functions of low and high beam. Adaptive light distributions optimally illuminate the road as required and thus improve active safety. Hella realizes this with just one swiveling AFS projection module with variable Xenon light distribution. The VARIOX® module generates all AFS lighting functions with one free-form drum:

- Town light is wide and without asymmetry, adjusted to illuminated town roads.
- Country light uses the new possibilities to improve the illumination of the road and the side areas when driving overland.
- Motorway light has an increased range in the center for long-range vision: objects up to a distance of 110 m can be recognized over the entire width of the road. Additionally, the asymmetry has been removed which is rather annoying for vehicles being overtaken on a motorway.
- High beam is also available in Xenon quality as standard lighting function with a maximal value of approx. 140 lx.
- Adverse weather light has a range between town and country light. The wide light distribution – slightly swiveled to the outside – enables improved orientation at the edge of the road. Additionally, the dazzling of oncoming traffic by light reflected from the road is reduced.

Headlamps with the VARIOX® module do not need variants for right-hand or left-hand traffic, because all functions are completely included.

Infrared Night Vision system ADILIS®

Conventional low beam is subject to a legal installation regulation to prevent dazzling of other road users, which limits the maximal range to around 60 m. However, despite the regulation, drivers are often dazzled by incorrectly adjusted headlamps, the result being that a driver can only conditionally see the scene into which it drives, which is one of the reasons for the still above-average number of accidents in the dark.

An overview in such complex traffic situations is provided by the ADILIS® infrared Night Vision system made by Hella, which illuminates with infrared radiation the road space in front of the vehicle, in a manner similar to high beam. A camera films the scene and displays the results on a display. In addition to relevant objects such as persons and obstacles, the system provides orientation assistance by making road course, road markings and traffic signs visible. This gives the driver a range of vision of around 150 m without dazzling oncoming traffic and other road users.

The illumination of the scene with infrared clearly distinguishes an active Night Vision system such as ADILIS® from the presentation of a passive Night Vision system. The driver is provided with a very natural and intuitively interpretable picture in which thermally cold objects can also be seen in addition to the objects mentioned above.



Improved vision with ADILIS®

In the future, ADILIS® will be able to detect objects in the direction of travel and provide a warning. In addition to this, the contents of traffic signs will be recognized in the future and made available to the driver.

ADILIS® – a system for more comfort and active safety. For more information, please see the separate information on ADILIS®.




LED systems



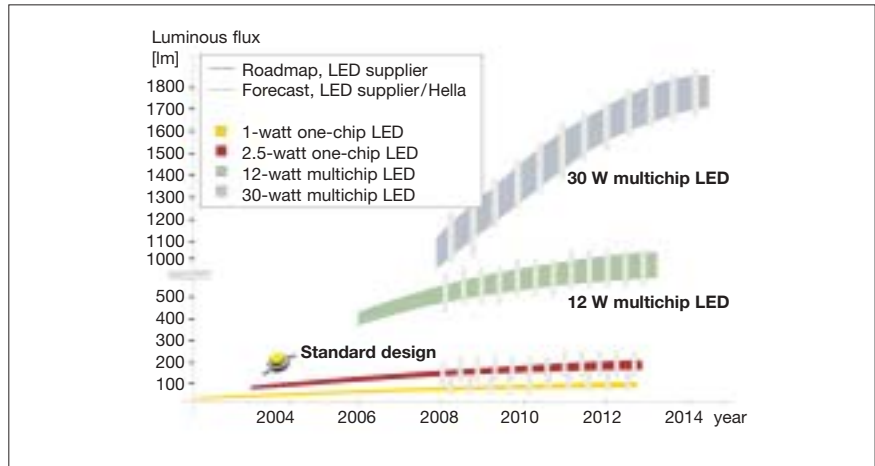
First series application with high-power LEDs in the headlamp

LEDs have been used by Hella since 1992 as a light source for signaling functions in the rear area. Use of LEDs in the front area previously has been thwarted by their low power. Based on continuous further development, the situation has changed considerably in recent years. In 2003, Hella realized the first application of high-power LEDs in a headlamp produced in series. Road map: LED light performance LED technology is currently at a turning point. Today, high-power LEDs are interesting not just for signaling, but for main lighting functions also.

If you look at the road maps of LED suppliers, it becomes obvious that in the foreseeable future LEDs will be a real alternative to halogen and Xenon light sources.

Light source	Luminous flux [lm]	Efficiency [lm/W]	Geometry [mm]	Max. luminance [Mcd/m²]
 Halogen bulb H7	1100	26	~ 1.4 x 4.1 (cylinder)	~ 30
 HID lamp D2S	3200	91	~ 1.2 x 4.2 (torus)	~ 90
 Light emitting diode	65 (2004) 80 (2005) 122 (2006)	~ 27 (2004) ~ 33 (2005) ~ 51 (2006)	~ 1.2 x 1.2 (square)	~ 12 (2004) ~ 15 (2005) ~ 13 (2006)

LEDs in comparison with other 5 W light sources



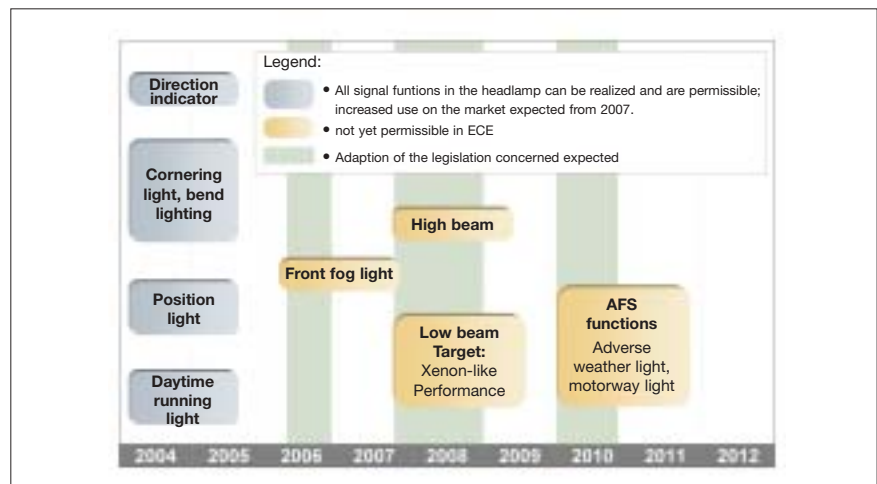
Road map: LED light performance

Standard construction types can be used only conditionally for main lighting functions. Better suited are special construction types which are developed in cooperation with the LED manufacturer. Such LEDs have been successfully tested in a prototype based on a series headlamp. The system depicted on the cover reaches a performance of more than 90 % of that of a Xenon system.



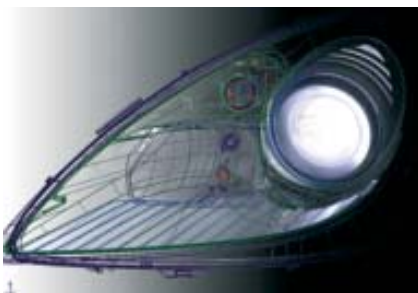
More examples of LED signaling functions in the headlamp: daytime running light and direction indicator, design samples

With regard to the introduction of LEDs as a light source for headlamp functions, alongside the technical challenge, legislation must also be observed. SAE guidelines today allow LEDs for both signaling and main lighting functions. The approval of main lighting functions by ECE standards is expected to become reality in the next few years, while signaling functions are permitted today.



Road map: LED application in the front area

Styling



Rendering

The definition of the styling has a decisive role in the development process of a headlamp. Any car manufacturer’s goal is, on the one hand, to ensure identification of “his” car and, on the other, differentiation from other manufacturer’s cars. In close cooperation, several design concepts are initially developed. Frequently, Hella’s own design department contributes decisive features to the shaping of opinion. Naturally, there are physical limits which are made clear by the specialists and are discussed jointly.

Light output and design complement each other via the use of and creative adaptation of advanced and conventional technologies to yield a headlamp system optimized in accordance with the requirements. Cooperation in the drawing up of the plans between all specialized departments as early as in the concept planning phase very quickly leads to satisfactory and technologically assured solutions.



Modular design, prepared for application of DDC

Dynamic Design Concept DDC

New technologies offer the possibility of individual adaptation to different equipment variants. The objective of DDC is the modular concept of a headlamp to enable the exchange of individual functions for the purpose of upgrading to a higher-value variant or upgraded model. For this, Hella offers comprehensive concepts and styling variants.

Pedestrian protection

To improve the protection of pedestrians in the case of a collision, stricter safety requirements apply even today to future vehicle models. The relevant EU Directives (2003/102/EC) will be extended in the future.

In the course of extensive examinations with tests and simulations, Hella has gained the know-how necessary for the optimization of headlamps with regard to the required characteristics.

A separate Technical Information document in which the interconnections are explained is available on this subject too.



Project example taking account of pedestrian protection, simulation

Lighting electronics

Simple headlamps can be switched on and off with a switch even today. The driver must not be bothered with more operating elements for additional functions. There-fore, such functions need to be controlled electronically. Hella has developed appropriate control units and concepts for the variable intelligent lighting system VARILIS® for various system architectures. The signals come from the cars data bus system. Combinations, in particular with electronic ballasts for special illuminants and headlamp leveling devices, suggest themselves.

For more details, please see our special “Lighting Electronics” prospectus.



Electronic components for headlamp leveling actuators



Electronic components for Xenon systems



Electronic components for VARILIS® systems

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