Technical Information

Electronics – Lighting Electronics

HELLA®

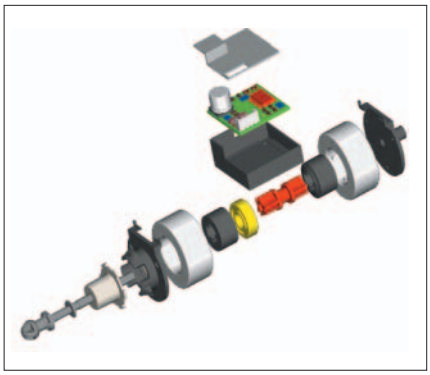
Ideas today for the cars of tomorrow

Product line lighting electronics

Seeing well is beneficial – being seen protects: electronics optimizes light functions

To complete the light electronic systems Hella uses synergies available through special knowledge in these fields. Xenon headlamp systems allow better illumination of the road and therefore better visibility by doubling the luminous flux in comparison to halogen headlamps. The ballast units required for this purpose for integration into the headlamp systems use highly integrated circuits and progressive mounting technology to achieve minimum overall size.

New light functions such as AFS (Adaptive Frontlighting System) can be realized in the limited package offered by modern front-end designs by integrating previously separated functions and using modular design to the greatest extent possible.



ISM

Hella has developed various solutions for headlamp leveling systems. In addition to the classic control unit/sensor/actuator architectures, systems with decentralized intelligence are being used increasingly. These include the familiar sensor-integrated electronic control units as well as the power module concept for the AFS systems and the Xenon 5 system with intelligent stepper motors (ISM).

Within the scope of AFS, numerous new light functions are being developed. Integration of additional functions into the headlamps increases the significance of intelligent headlamps. Mechatronics is a synthesis of mechanics and electronics offering high potential for advanced development of lighting engineering systems.

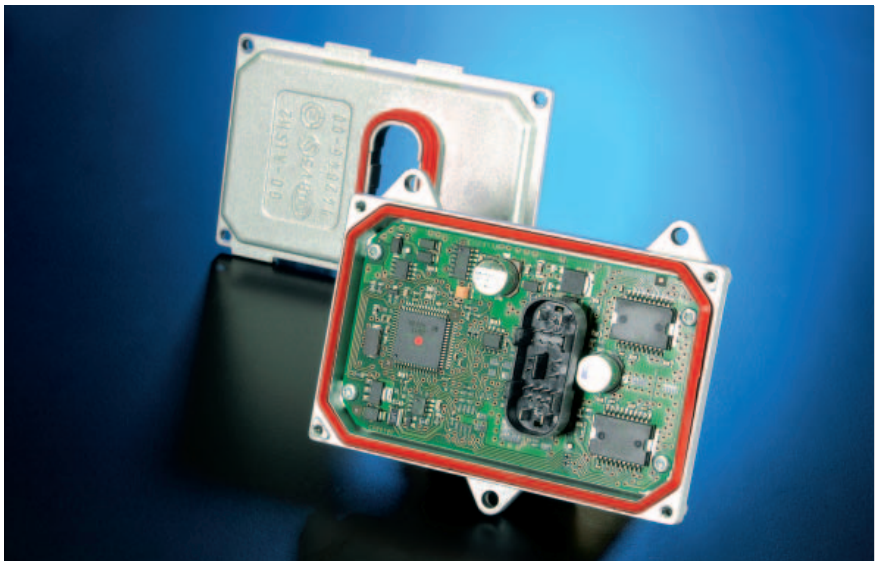
Snap-in concept for headlamp levelers 3i

Standard range

- Electronic control units for Xenon lighting systems
- Bi-Xenon systems
- Manual electric headlamp leveling
- Automatic headlamp leveling systems
  - Static
  - Dynamic
- Vehicle level sensors
  - Inductive (PWM/analog)
- Sensor-integrated headlamp leveling control unit
  - Static
  - Dynamic
- Stepper motor with electronics
- Headlamp leveling/light power module component system

Innovations

- Mechatronics for Adaptive Frontlighting Systems (AFS)
- Alternative headlamp leveler sensors
- Intelligent stepper motor (ISM)
- Modular Xenon 5 AFS system
- Halogen AFS system



Headlamp leveling/light power module

Xenon ballast unit

Hella is the market leader for Xenon lighting systems in Europe. Electronics take over the regulation of the start-up, the constant power output as well as the control in case of a malfunction.
The Xenon system consists of a ballast unit, an ignition unit for the Xenon gas discharge lamp and the lamp itself.

Sometimes the ignition of the Xenon lamp requires a short term high voltage in the range of over 20 kV.
The Hella system therefore provides a conclusive safety concept for switching off the unit in case of a malfunction.

The Xenon ballast unit has the following system characteristics:
- Separate ignition unit for fixation to headlamp reflector
- Wiring integrated in the headlamp housing
- Increased temperature resistance through design with SMD components on ceramic substrate using heat-sink technology
- Fail-Safe device
- Possibility for self-diagnosis in combination with integrated light control unit

Xenon 4 system

Since the beginning of 2001 the 4th generation is on the market worldwide in numerous vehicle models.
The Xenon 4 system consists of a ballast unit, the Hella ignition unit and a Xenon gas discharge lamp. It is available as a filtered and shielded version which is EMC optimized.

Xenon 4 ballast unit with separate ignition unit

Xenon 4.1 system

The Xenon 4.1 system represents a further development of the Xenon 4 system. It operates a Xenon gas discharge lamp with integrated ignition unit (D1 lamp).

In comparison to the Xenon 4 system, the Xenon 4.1 version is distinguished by the following points:

- Further reduction of volume and weight
- Improved EMC performance through fully shielded system
- Optimized integration capability into headlamp system

Alternative, it is also possible to operate the gas discharge lamp with the Hella shielded ignition unit.

Xenon 4.1 ballast unit with D1 lamp, alternative with shielded Hella ignition unit and D2 lamp

Further development of the Xenon systems is concentrated on optimizing the units at a high quality level in terms of cost and overall size. The target is completely equipping all vehicles with Xenon lights from all available models down to the lowest vehicle in class.

Prescribed by legal regulations, installation of Xenon light requires additional components such as headlamp powerwash system and automatic headlamp leveling in many countries. Since all components are included in the Hella product range, it is possible to realize a matched overall system as a high performance product.

Particular focus is placed on optimization of the integration capability of components into the headlamps. The comprehensive light/electronic competence allows us to offer customers optimized complete systems.

Manual headlamp adjustment

Electronic headlamp leveler 3i

Hella has developed various solutions for manual headlamp leveling. Electronic headlamp levelers have asserted themselves, which are now produced in the 3rd generation with new optimized features (version 3i)

Hella offers optimal, customer-specific system solutions. We produce actuators for integration into the headlamps as well as actuators for external assembly. These are available in 12 V and 24 V with and without manual basic adjustment. A fully automatic production with high quality standards ensures a daily volume of 40,000 units.

Automatic headlamp leveling systems

Components of dynamic headlamp leveling device: stepper motor, control unit, inductive sensor

Safe driving in the dark is only possible with headlamps which angles of inclination are always adjusted correctly. This is the only way to ensure that the road is illuminated optimally without dazzling oncoming traffic.

With the manual headlamp leveling, common in vehicles today, the driver has the possibility of adjusting the headlamp inclination to the specific loading condition with a switch on the dashboard.

The automatic headlamp leveling systems developed by Hella adjust the angle of inclination of the headlamps to the angle of the body without the driver's assistance. We differentiate between two systems. The static headlamp leveling system corrects the inclination resulting from changes in the load condition. Over and above this the dynamic headlamp leveling system reacts to changes in the inclination resulting from braking and acceleration maneuvers.

Headlamp leveling systems with separate control unit

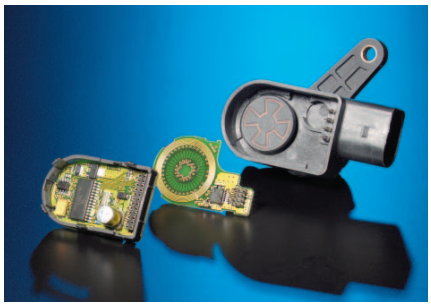
In contrast to static headlamp leveling, which in the ideal case (on compact vehicles) manages to achieve good control results with a so-called one-axle scan, dynamic headlamp leveling requires a vehicle level sensor on both front and rear axles. From the suspension compression data supplied by the sensors, the control unit calculates the required inclination angle for the headlamps.

Intelligent filtering ensures that the headlamp adjustment is corrected immediately at high speed in dynamic driving situations while realizing a smooth light impression without irritating adjustment motion at continuous driving.

The control units for static and dynamic headlamp leveling are realized using bus interfaces. At the end of the car manufacturer's assembly line the control unit can be adapted to various vehicle models by coding or programming vehicle-specific parameters. This provides a high degree of flexibility with a small number of variants.

Sensor-integrated headlamp leveling control unit

In a further development step, the external control unit was integrated into the axle sensor for automatic headlamp leveling control on compact vehicles: Sensor-integrated Electronic Control Unit (SIECU).



Sensor-integrated control unit

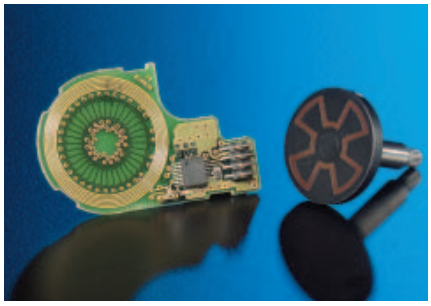
The basis for the sensor-integrated headlamp leveling control unit is the inductive vehicle leveling sensor. The mechanical interfaces, i.e. mounting and sensor lever, as well as the overall dimensions correspond to those of the axle sensors.

Scanning with one or two-axle sensors in static as well as dynamic version right up to AFS are possible using a modular concept. It is not necessary to modify the vehicle wiring for the change.

A sensor-integrated control unit on the rear axle for automatic headlamp leveling control is not limited to vehicles with Xenon headlamps, but can also be used to replace manual headlamp adjustment units on vehicles with halogen headlamps. This gives an improvement in comfort and safety.

Inductive vehicle level sensor

For a number of vehicle equipment packages designed to increase safety and comfort such as an active suspension, a level regulation and an automatic headlamp leveling device, it is necessary to record the relevant inclination angle of the vehicle.



Inductive sensor

In the case of the inductive vehicle level sensor there are several current-carrying coils placed on a circuit board which produce an electro-magnetic field. A metallic rotor connected to the sensor actuation lever is moved above this circuit board thereby influencing the electro-magnetic field. Other coils located on the circuit board receive a field depending on the lever position of the sensor and this field is evaluated by an ASIC which has been especially developed for this purpose.

This sensor allows different angle ranges to be realized with uniformly high linearity. The inductive axle sensor provides an analog signal as well as a PWM signal. The sensor principle operates fully independently of the temperature and obtains excellent accuracy. The sensor zero position can be varied to match the specific application.

Sensor assembly

A further development of this sensor is the new inductive sensor, which supplies a recurring PWM signal compressed to 90 %.

This sensor can therefore be used on all platforms as an equivalent part. Various installation positions and mounting tolerances can be compensated by electronic adjustment in the evaluating control unit.

ISM (Intelligent Stepper Motor)

The intelligent stepper motor combines the conventional bipolar stepper motor with the power electronics which is normally contained in a separate control unit. Today they form one mechatronic unit (see figure on page 2). The primary component of the ISM is an ASIC for realization of complete stepper motor control and diagnosis as well as the interface to the master system over a communication module with integrated LIN bus interface.

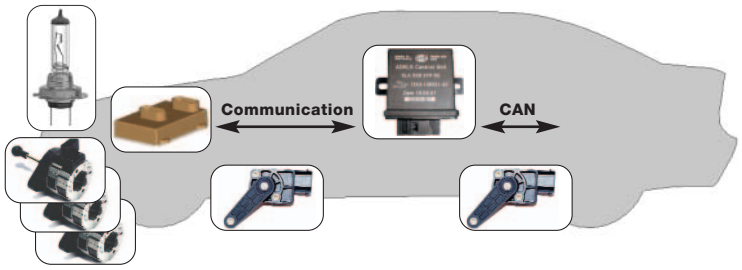
The primary functional advantages of the intelligent stepper motor include:
- Microstepcontrol (low noise and low resonance operation)
- Step loss/block up recognition (shortened reference run)
- Field-oriented current control (optimized power balance)
- Diagnostic capability
- Improved EMC performance

Hella uses ISM technology particularly for the AFS systems and equips dynamic bend lighting and VarioX cylinders with intelligent stepper motors. This is in addition to the classic ISM variant, the intelligent stepper motor for dynamic headlamp leveling control.

Mechatronics for AFS (Adaptive Frontlighting System)

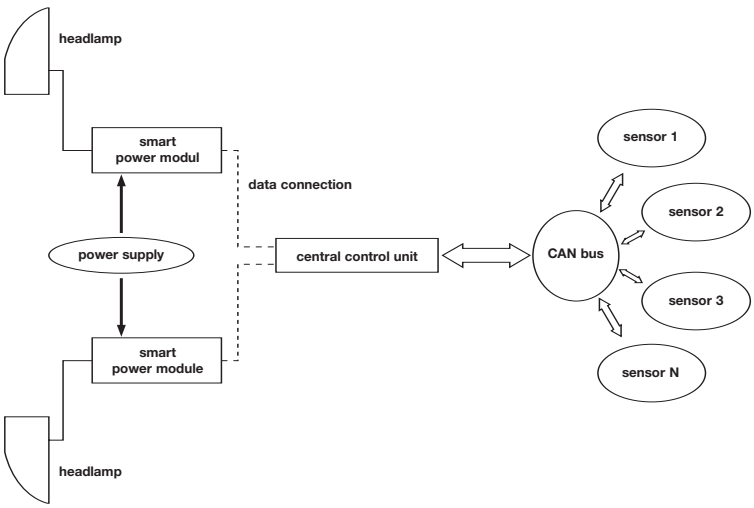
System with headlamp leveling/light power modules

The Adaptive Frontlighting System is one of the most important current technical innovations in the fields of lighting. It includes light distribution for town, country and motorway situations and in addition to move the lights to follow the course of the road or the direction in which the vehicle is turning. Realization of situation-adapted light distribution by the Hella VarioX system and realization of direction-adapted light in the short range and long range using so-called static and dynamic bend lighting require a concept matched to such applications for the electronic control using mechatronics and algorithms.



System components: dynamic HL and AFS

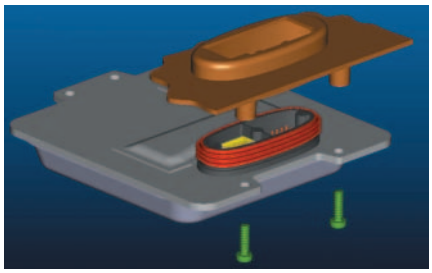
With the systems coming onto the market, Hella uses decentralized electronics. A central light control unit is responsible for editing the appropriate control strategies (algorithms). This control unit – in principle a sensor-integrated control unit is also possible here – sends its data via a communication bus to a power module attached to the headlamp, which then uses appropriate actuators for final control. Various optimally adapted power modules are available for different configurations. The modular concept ensures optimal adaptation using standardized components.



Modular concept with power module

Technical advantages of this modular concept include:
- Reduction of wiring through the engine compartment
- Reduction of plug connectors in critical surrounding area
- Simple extension of the concept through further lighting engineering functions
- CAN connection in critical vehicle area (crash zone) can be avoided
- Full diagnostic capability
- Independent fail-safe reactions

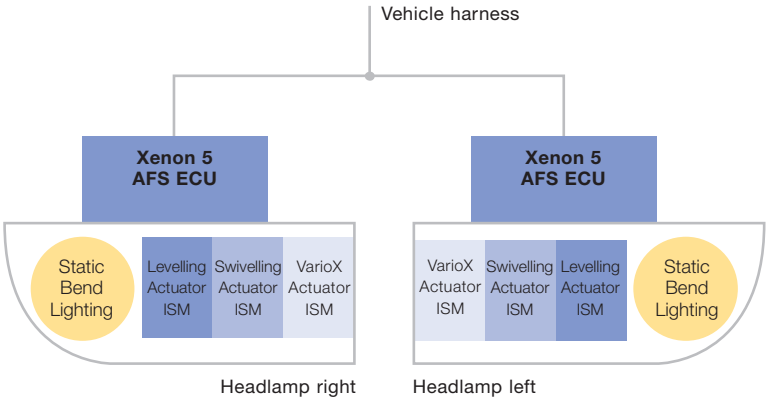
Xenon 5 system with ISM as control unit for AFS and Xenon gas discharge lamps



Xenon 5

The requirements of the market for a reduction of the number of control units for an AFS system will be satisfied by the 5th generation Xenon system. One Xenon 5 control unit on each headlamp controls all AFS headlamp functions:

- Operation of Xenon gas discharge lamp.
- Control of actuators for dynamic headlamp leveling control, for static bend lighting, for dynamic bend lighting and VarioX cylinder for generation of different light distributions.



Modular concept with Xenon 5 and ISM

The control units evaluate the vehicle network information – such as speed, steering angle, yaw rate, ambient light – and control the light distribution depending on the driving situation using a complex algorithm. This is accomplished by interaction of all actuators in one headlamp as well as influencing control of the light output of the Xenon gas discharge lamp. An intelligent fail-safe strategy ensures that the vehicle continues to fulfill all legal lighting requirements even in the event of a malfunction. A modular system design allows the same control unit to be used for various headlamp versions; the requirements for the interface to the vehicle remain the same for all headlamps. Programming of different versions can be accomplished in the customer's production facilities after installation of the headlamp and connection to the vehicle network.

Herewith, Hella Lighting Electronics provides a further contribution for increasing customer flexibility.

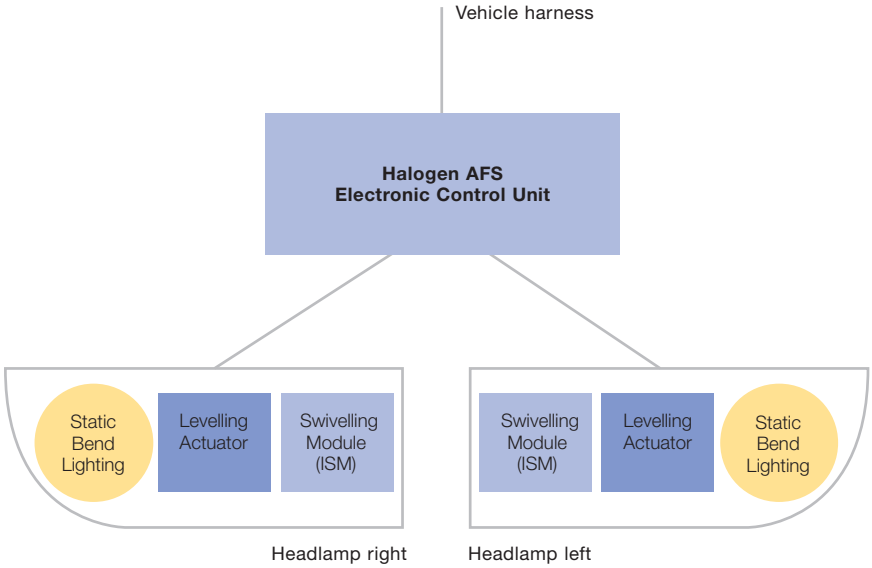
The following optimizations are realized with this system:
- Control of the VarioX actuator
- Control of light power output of Xenon gas discharge lamp
- Further reduction of volume and weight
- Improved EMC performance with fully shielded system
- Optimized integration into headlamp system
- Component related diagnosis
- Independent fail-safe reaction

Halogen AFS Control unit

Identical to the Xenon AFS, Hella uses decentralized electronics for the halogen AFS.

We can offer our customers two different halogen AFS systems. The cost and function optimized version consists of a separate control unit with optional ISM actuators for dynamic bend lighting. The version with headlamp leveling/ light power module architecture allows the use of AFS functions for halogen as well as Xenon headlamps for the same vehicle model.

The central halogen AFS control unit is responsible for processing the appropriate control strategies (algorithms). Control of the static bend lighting as well as the headlamp levelers is accomplished in the halogen AFS control unit. Furthermore LIN bus compatible swiveling modules with ISM allow dynamic bend lighting. This configuration makes optimum adaptations to customer requirements possible.

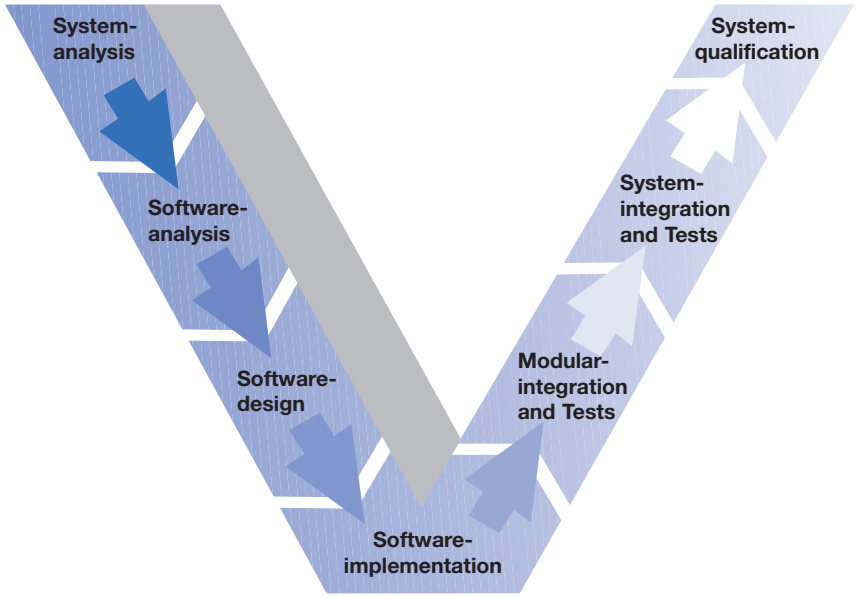


Modular concept with halogen AFS

Development method

Hella uses model-based procedures for software development. During the development process, new functions are incorporated into the mechatronic systems using simulation tools and rapid prototypeing methods (software/hardware).

This ensures that functions are first realized with a simulation model corresponding to the procedure for the so-called V-model.



V-model

With this analytic approach, a tool is available for complete consideration of the interaction within the system (software/hardware) at an early stage in the software development. This method differs basically from conventional software development. The simulation model is implemented in a development environment where the “newly developed” functions can be tested and experienced in a test environment (test bench) as well as in the real environment (vehicle) under real conditions (real roads).

This procedure ensures time efficient working methods; modifications can be made quickly and easily and simultaneously offers the possibility of rapid fault analysis. After the “new” function algorithm has been confirmed in this manner, a program code for the target hardware can be generated automatically from the simulation model. This makes software development more efficient as well as more transparent in comparison to previous methods.

Furthermore, additional application possibilities such as Hardware-in-the-Loop (HiL) tests, Software-in-the-Loop (SiL) tests, measuring data capture and analysis as well as FMEA are possible.

This development model represents a good platform for cooperation between car manufacturer and supplier.

Hella KG Hueck & Co.
Rixbecker Straße 75
59552 Lippstadt/Germany
Tel.: +49 (0) 29 41 / 38-0
Fax: +49 (0) 29 41 / 38-71 33
Internet: www.hella.com

For technical enquiries:
PLE-4 Lighting Electronics
Tel.: +49 (0) 29 41 / 38-84 43
Fax: +49 (0) 29 41 / 38-80 78

Ideas today for
the cars of tomorrow