Technical Information

Light – ASIGNIS® Adaptive Signal System

Ideas today for
the cars of tomorrow

ASIGNIS®
Adaptive Signal System

Introduction

Following the successful introduction of the first adaptive functions for headlamps, it has become clear that a significant leap in quality still has to follow to improve the rear signal image. Stop light, indicator and rear light functions always work at the same luminous intensity despite different environmental brightness and visibility conditions such as snow, rain and fog. A differentiated statement about the braking behavior of the vehicle in front is not part of the current regulations.

With “ASIGNIS” (**A**daptive **Sign**al **S**ystem) Hella has developed a concept where rear-end lighting perceptibility is improved in all lighting and weather conditions as well as in critical traffic situations, while retaining compatibility to the current signal image.

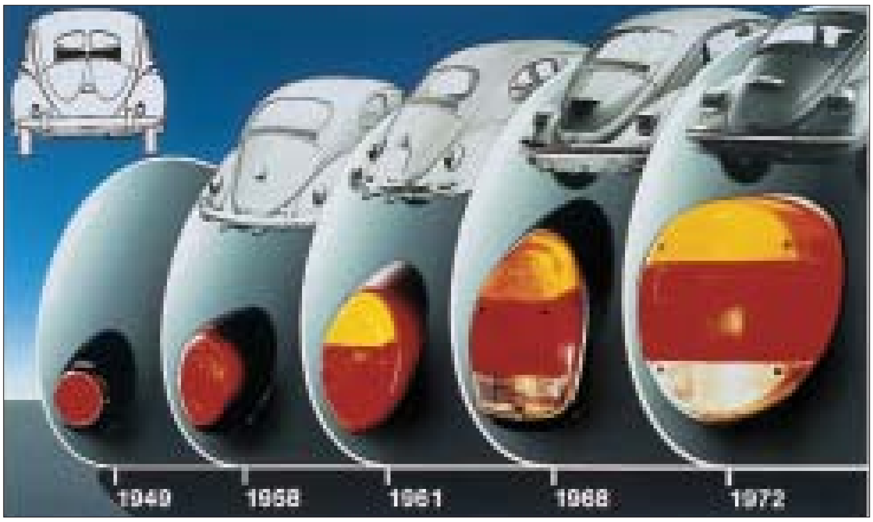

Fig. 1: Historical development of rear-end lighting

Requirements for an adaptive rear signal image

The most important basic condition for the development of an improved rear signal image is the fact that the current standard has developed historically and can be recognized spontaneously and intuitively across the world's cultures. Accordingly, every change to existing signal functions must be clearly and spontaneously recognizable. Additional information must be able to be clearly interpreted by all road-user groups. Mixing the existing and new signaling images in road traffic must not create confusion or dangerous traffic situations.

Parameters that could be used for an adaptive signal image are:

- The **brightness** or the luminous intensity of the signal function which can be used for adaptation to visibility conditions and/or environmental brightness, for example.
- The **illuminated area** of the signal function which draws increased attention to itself when it changes and can thus be used in the same way as the
- **Frequency,** which is currently only used for the direction indicator and the hazard light as an additional warning signal.

Changes in driving situations which are to be adaptively displayed using the three possibilities mentioned above can be summarized into four categories:

1. Hazardous situations
Should be displayed differently than standard braking situations. For example, the hazardous approach of the following vehicle can be indicated, as well as emergency braking or ABS and/or ESP activation.

2. Ambient brightness
Here, the continual and differentiated bright or dark adaptation of the human eye has to be taken into account.

3. Weather
Rain, snow and fog require adaptation of the signaling intensity to be made depending on their photometric effect.

4. Soiling
Compromises lamp safety and can be corrected by both cleaning measures and increased brightness.

Basic elements of the adaptive signal system ASIGNIS®

Adaptation of the luminous intensity of the signals and the generation of a hazard signal can be considered separately.

Dynamic hazard stop signal
The desire to signal deceleration as well as to communicate the intensity of the braking process to following traffic has been presented in numerous publications, patent applications and prototype structures. In terms of practical implementation, the compatibility requirements mentioned above must be considered as well as the fact that we are not always able to cope with the wide variety of information presented in traffic situations. In other words, the registering and interpreting of a too-differentiated signal can result in confusion and additional reaction time.

An emergency stop signal should therefore be limited to really strong deceleration and be visible for only a few stages. Specialist organizations favor a deceleration value of 6 m/s^2. Since uncontrolled driving conditions are particularly risky, the delayed (> 0.5 s) intervention by active driver-assistance systems such as ABS and ESP also should trigger such an emergency braking signal.

For signaling, those changes in signals are predestined which draw a particularly high amount of attention. An increase in surface indicates that an emergency stop is being made, especially if an extra surface is additionally switched on with a small but still clearly obvious delay. If the photometric variations resulting from this are within the permissible photometric ranges, the use of such a system is already possible. BMW has been introducing this concept successively into its model series since the end of 2003 **(Figure 2)**.

Fig. 2: Hazard stop signal by increasing the signal area (BMW)

The high warning effectiveness of a flashing signal is being followed up in another concept that is being discussed and investigated internationally. Here, the stop light is pulsed at a significantly higher frequency than that usually used for the turn signal. Since LEDs react much more quickly than filament bulbs, this system is particularly effective. LEDs make a particularly striking impression at frequencies upward of about 7 Hz. Due to the slow reaction time of filament bulbs, only lower frequencies can be used, which reach their optimum at approx. 3 Hz, depending on the bulb type.

Another possibility which has been discussed is switching on the hazard warning lights in addition to the stop light in hard-stop situations. This follows the practice of switching on the hazard warning lights when driving up to a traffic jam in order to indicate the special danger. LED technology also provides increased warning effectiveness for this scenario. When LEDs are used, the design must take into account that the pulsed operation in the switch-on phase allows higher operating current and thus greater brightness since the operating conditions for LEDs are usually determined by the overall thermal situation.

Adaptive light control

The aim of adaptive light control is the same perception and recognizability of the signal function in various weather and visibility situations. The basic thought behind this is to regulate the luminous intensity of stop light, indicator and tail light in such a way that poor visibility caused by rain, snow or fog as well as differing brightness adaptation of the eye is compensated by readjustment of the luminous intensity of the signal function. Soiling of the combination rear lamp – which occurs quickly in bad-weather driving from swirling dirt particles – can also be integrated in this function.

The control signals for ambient brightness can be obtained from brightness sensors which are sometimes already included in premium equipment vehicles. The detection of the degree of soiling on the combination rear lamp can be achieved at justifiable expense by integrating an appropriate sensor using reflection principles in the combination rear lamp. It must be noted, however, that heavy soiling on the lamp can result in transmission reductions of up to 90%, the photometric consequences of which cannot be compensated economically. Possible solutions: the installation of a rear lamp cleaning system (similar to the ones already used for headlamps) or the generation of a signal which indicates the necessity of cleaning the combination rear lamps once a certain degree of soiling has been reached.

Visibility range can also already be measured by today's sensor systems. As well as examining whether the sensor concepts are feasible in economic terms, the most important task in implementing adaptive light control is the evaluation and linking of the sensor signals in such a way that the system can be optimized using the smallest possible number of low-cost sensors.

The possibility of adapting signaling functions to visibility conditions results in a new quality prospect for the tail light function. At the moment, where the tail light has a level of 4–12 cd, the rear fog lamp (150–300 cd) may only be switched on as a “stronger tail light” when visibility is down to less than 50 m. Adaptive control of the tail light would allow the tail light to become continually stronger as visibility conditions deteriorate and thus include weather conditions where visibility remains greater than 50 m but still causes significantly reduced visibility – conditions which occur much more often than dense fog **(see Fig. 3)**.

Fig. 3: Adaptation of the signal image to different ambient brightness

As well as taking the strain off the driver, who is often unable to estimate visibility exactly, the automatic adverse weather tail light also provides advantages for the lamp structure. Currently, the stop light and rear fog lamp must be at least 100 mm apart to avoid confusion. The automatic adverse-weather tail light would replace the need for a rear fog lamp and provide possibilities for other lamp geometries and designs. It is worth mentioning at this point that the use of a daytime and night-time brightness level is already permissible within the ECE approval zone. Dynamic control within this range is not permissible yet, however.

Interfaces and integration

It has clearly been shown that an adaptive combination rear lamp system requires a much more complex scope of processed-signal information. In today’s well equipped vehicles, there is plenty of information about brightness, rain, speed and brake-pedal pressure, as well as ESP and ABS activity, already available in the electric system. Additional sensors need to be integrated to determine the soiling of the outer lenses and their visibility. The technology for such sensors is already available and is currently being optimized in terms of economical feasibility.

Equally, matching and algorithm formation of the sensor signals mentioned above is taking place in order to achieve the best possible physiological adaptation. Central processing of data which can be received via the CAN bus can take place in a central rear-control unit or even directly in the combination rear lamp itself (at least in part) if some of the required sensors are located there (for example, dirt or visibility sensors) **(see Fig. 4)**.

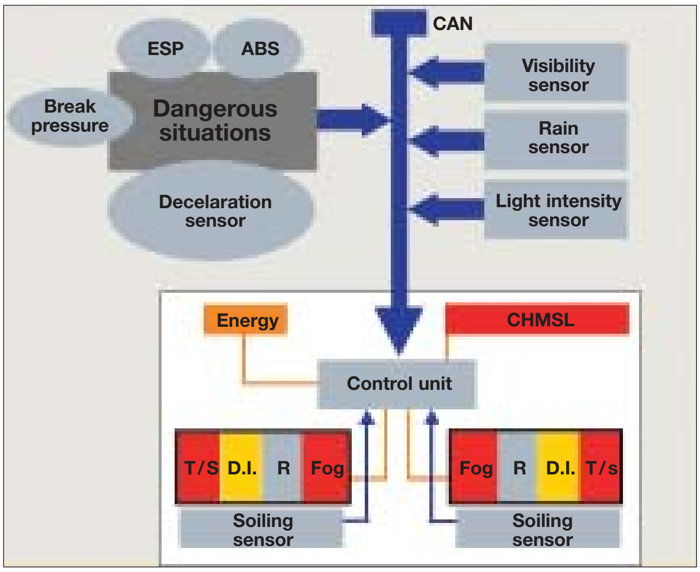

Fig. 4: Control of an adaptive signal system ASIGNIS®

In the long term, premium combination rear lamps, designed completely with LED technology, have the perspective of a support structure which will house both the LED light sources and the structural elements required for controlling the lamp and signal processing, including the sensors.

Implementation and perspectives

Since the hazard stop signal generates additional information with a high safety-related value, this is the option most often discussed in trade journals so far. It is to be expected that, along with the introduction of the 2-stage stop light by BMW (refer also to section 3.1), the possibility of the stop signal flashing to indicate emergency braking will be approved in the next few years. Another strong reason in favor of this development is the fact that the technological expenditure involved is relatively low thanks to the number of signals already available.

The legislative phases for implementing adaptive light control will be significantly longer, however. The change to the photometric values affects no less than three signal functions – stop light, indicator and tail light – which also have to be evaluated in their relation to one another. Initial suggestions for extending the light level for dynamic control are already being discussed by the pertinent bodies.

At the same time as the paths in the legislative bodies are being smoothed, further technological developments will facilitate more economical integration of the adaptive functionalities presented in this booklet. The scenario of a vehicle that not only guarantees optimum situation-dependent illumination of the road thanks to adaptive headlamp systems, but at the same time achieves the best possible signal image for following traffic, will be technically possible before the end of the decade.

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