Technical Information

Lighting – Signal Lighting

HELLA®

Ideas today for the cars of tomorrow

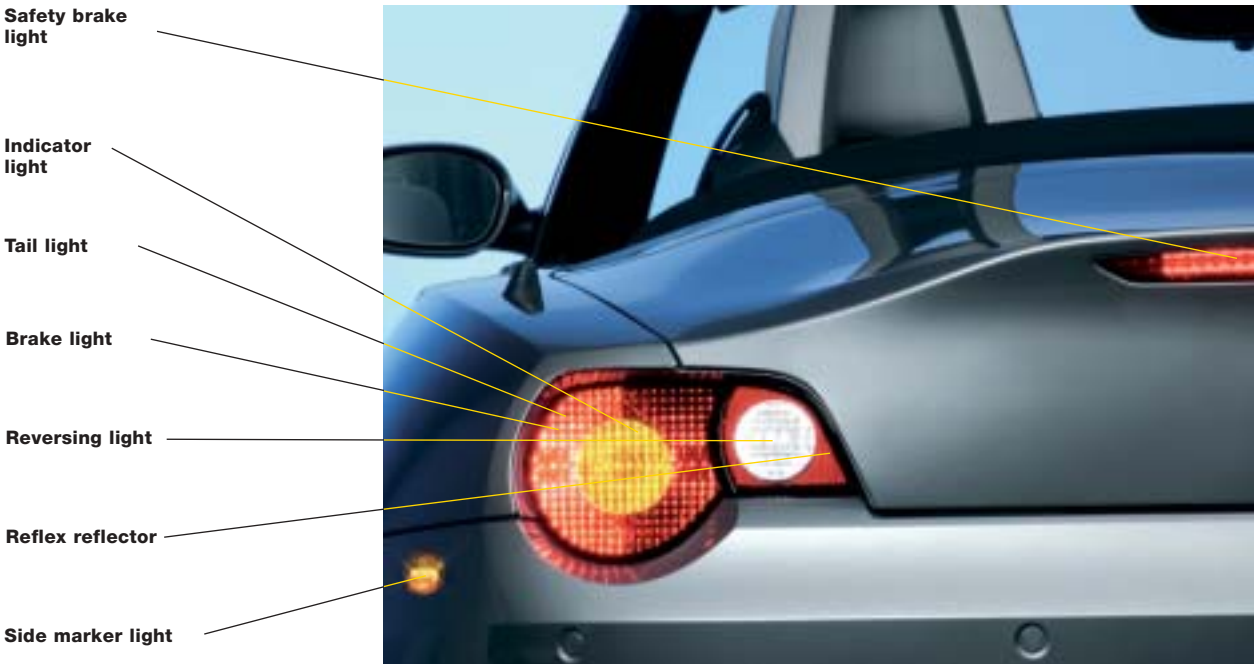
Exterior lamps – whether attached at the front, the side or the rear of the vehicle – inform other road users by means of their signals.

They indicate whether

- a vehicle is there at all (position light, side marker light, tail light, rear fog light, side and rear reflex reflectors)
- a vehicle is braking (normal brake light and centre high mounted stop light
- a vehicle is changing direction (front, side, rear indicator light)
- a vehicle is reversing (reversing light)

Reliable light signals that can be clearly recognised are a must for active traffic safety. The logical conclusion from increasing traffic density, increased safety requirements and the increasing flood of information therefore has to be: To recognise quicker and be seen better!

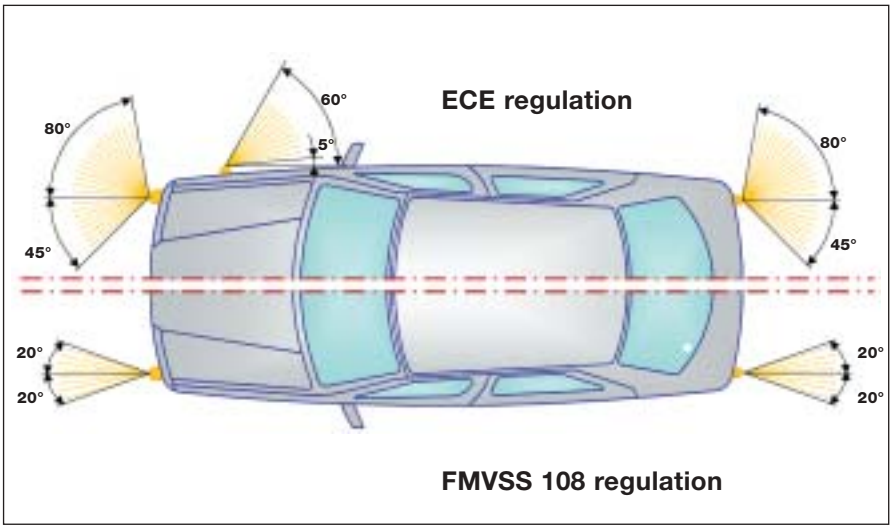
The signal functions on the vehicle differ in their luminous intensity and their colour. The signals have to be unambiguous and unmistakeable. They have to be able to be recognised safely by road users in all traffic situations, weather conditions and lighting conditions by day and night. This increases both the safety and driving comfort of drivers – a particularly important aspect with regard to today's mobility. The introduction of the centre high mounted stop light was one example of this. The implementation of a new adaptive signal image that takes visibility conditions and special hazardous situations into account will be a further step in this direction.



Rear lighting

In order to standardise the signal image, requirements for vehicle signal lamps are laid down in the form of legal regulations. Basically, every state has its own nationally valid regulations. In Germany, this is the Federal Motor Vehicle Safety Standards (StVZO – Straßenverkehrszulassungsordnung). In addition, there is a higher order set of regulations which all European states accede to and which are being recognised by more and more often by states outside Europe, too. These are the ECE regulations. Alongside these, the European Community also has EC guidelines which – as far as vehicle signal lamps are concerned – have almost the same wording as the ECE regulations.

In the United States of America the relevant regulations are summarised in FMVSS 108 which is based on SAE standards. These regulations are also accepted by other states.



Angle of visibility for direction indicators (ECE/FMVSS 108)

In order to generate a clearly visible signal image despite varying environmental brightness, the ECE regulation provides for the possibility of using different luminous intensities, e. g. for day or night conditions.

ECE 2-stage brake light: daytime level

ECE 2-stage brake light: night-time level

Light sources

In the past, filament bulbs were usually used to produce the signal image in lamps. In the European regulations (ECE, EC), the word “filament bulb” has now been replaced by the word “light source”. This means that other light sources, e. g. light emitting diodes (LEDs) can now be used alongside filament bulbs.

A distinction must be made, however, between replaceable and non-replaceable light sources. Replaceable light sources are only those that have been awarded type approval according to ECE regulation no. 37. Light sources that are not included in ECE regulation 37 (certain types of filament bulbs and light emitting diodes) may only be used if they are non-replaceable. The American regulations (FMVSS 108) do not make such a distinction. In other words, all light sources that are available on the market may be used in the US in vehicle signal lamps.

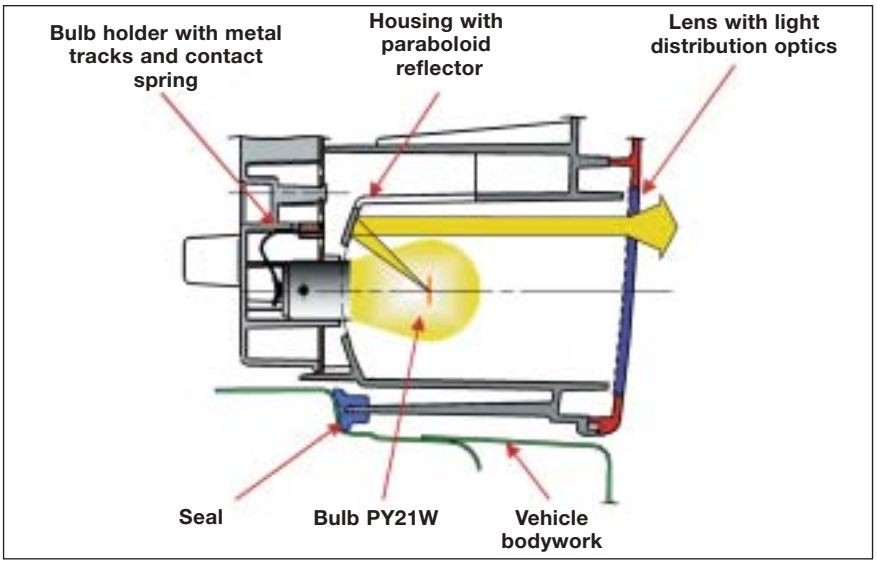
	Typical filament bulbs according to ECE regulation no. 37		
			
Designation	**P21W**	**PY21W**	**P27W**
Power consumption	25 W	25 W	29.2 W
Luminous flux	460 lm	280 lm	475 lm
Service life	200 h	200 h	580 h

	Non-replaceable light sources			
				
Designation	**Filament bulb**	**LED**	**High-power LEDs**	**SMD**
Power consumption	16 W	0.15–0.5 W	1–2 W	0.15–0.25 W
Luminous flux	300 lm	2–10 lm	10–50 lm	2–6 lm
Service life	1,500 h	>10,000 h	>10,000 h	>10,000 h

Optical systems

A vehicle signal lamp is basically made up of three parts: the light source holder, the lamp body, cover lens and additional optical elements if necessary.

The light source holder positions the light source(s) correctly in relation to the optical system of the lamp. The lamp housing contains the reflectors which are usually moulded-on. The cover lens, sometimes only known as lens,is either without optics or distributes the light in combination with the reflector.



Cross-section through a lamp with filament bulb

In order to fulfil technical requirements, the light of the light source(s) has to be collected and directed, deflected and distributed. Optical elements with reflective or refractive properties are used for this purpose.

Different appearances

Light distribution

Reflector technology

Light guide technology

Light guide technology

Development strategy

The basic framework for the development of signal lamps is a result of

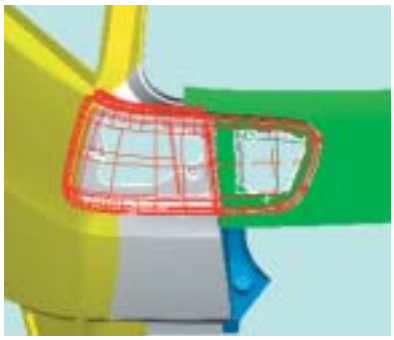
- the legally prescribed technical lighting requirements for the various signal functions
- the specific mechanical customer requirements
- the customer-specific styling requirements
- the technical ability (know-how) of the developer or the manufacturer of signal lamps for automotive applications

The basic procedure for the development of a combination rear lamp shall be described in brief and illustrated in the following using an example. The first step is to model an initial concept on the basis of customer CAD data, taking customer design ideas into account and including all the necessary technical signal lighting functions (tail light, brake light, indicator etc.).

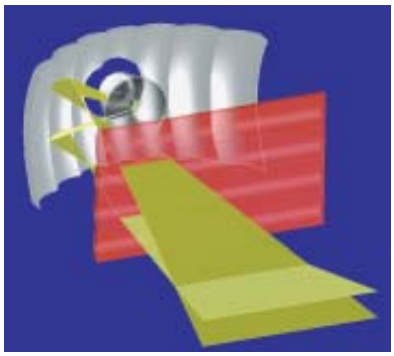
Using optical simulation programs, the optical system of the respective signal function is then checked to make sure it adheres to the relevant technical regulations and, if necessary, adapted iteratively to the requirements.

Using these two suggestions, an initial draft combination rear lamp is then generated as a styling suggestion.

Parallel to the above procedure, the possible manufacturing technology is checked and guaranteed using relevant design samples if necessary.



CAD data from the vehicle manufacturer



Simulation – technical requirements

Suggested design for combination rear lamp

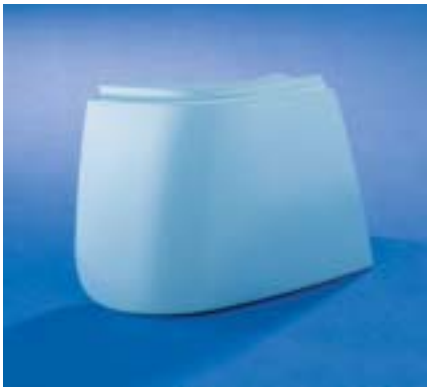
Vehicle combination rear lamps – standard series parts

Volume model
The model is milled from modelling material with great dimensional accuracy. It is used to check the CAD data and for collisions analysis within the vehicle.

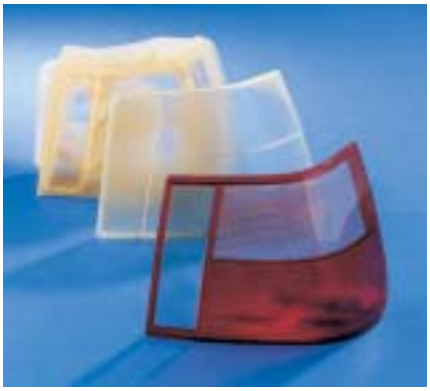
Styling and functional sample
This is produced using rapid prototyping methods (e. g. stereo-lithography, fused deposition modelling, selective laser sintering, vacuum casting) or using classical modelling methods. Styling samples are used for monitoring mechanical and technical lighting functions.

Prototypes made of aluminium tools
Devices close to the production stage are produced using aluminium tools. These prototypes are installed in pilot series vehicles.

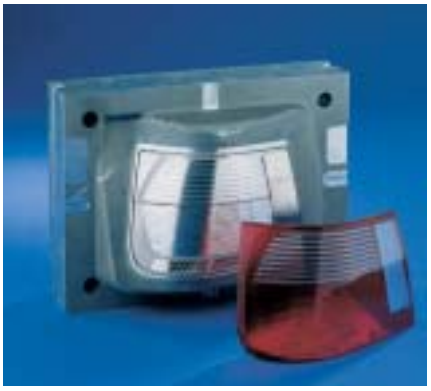
Standard series devices
The standard series device is produced using standard series tools.



Milled model



Lens made of vacuum cast
Body made of laminate



Lens and body made using aluminium tools

Device made by standard series tools

Signal lamps

Rear combination lamp, units in one or more parts

Different designs of combination rear lamps

Safety brake lights

Safety brake lights can be mounted inside the rear window or on the outside of the vehicle. If they are on the outside, they are usually integrated in the spoiler or the bodywork.

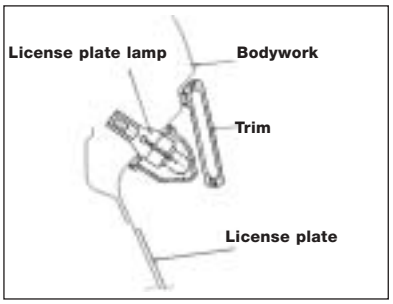
Safety brake lights for inside and outside mounting

Indicator lights/Side marker lamps

Front indicator lights can be integrated separately in the bumper, bodywork, next to the headlamp or in the headlamp.

Different front indicator light/side marker lamp designs

According to European approval regulations, indicator lights must be mounted at the side of the front end of the vehicle. According to American approval regulations, this function is not mandatory but it is permitted.
The side marker lamps and side marker reflex reflectors permitted in Europe represent a further gain in safety. These signal functions are mandatory in the USA.



Mounting situation of a license plate lamp

License plate lamps

License plate lighting is exactly prescribed by the legislator in terms of beam pattern and light intensity. Usually, one or two license plate lamps are mounted either at the side, above or below the license plate. They can be integrated in the bodywork, in rear trim or other mounted parts such as the rear bumper.

License plate lamps: representation of different light colours conventional/LED

System features

Service/Failure safety

Lamps are subject to the toughest tests and checks according to both legal regulations and specifications of the vehicle manufacturers to ensure that they meet the requirements of a whole vehicle service life. The use of particularly long-life light sources, e. g. LEDs, makes an important contribution to increasing the safe functioning of the lamps.

Vibration test

Safety/Quick signal perception

With conventional filament bulbs, the filament bulb needs approx. 200 ms before it has warmed up sufficiently to send out light at the required brightness. LEDs do not require a warm-up phase at all. When these are used as light sources, the stopping distance can be shortened by around one vehicle length for a hard stop – assuming a speed of 100 km/h.

Different exterior lamps

Styling/Ergonomics

Exterior lamps are influencing the individual appearance of vehicles more and more. They are eye-catchers and can either support bodywork shapes or consciously break these up. New production technologies such as pattern-less cover lenses or free-form reflectors and new lighting technology such as light guides or LEDs allow design engineers a wide variety of design possibilities. The designer's task is to combine these possibilities from design, ergonomic and production points of view in such a way that an optimum product is the result.

Alongside work close to the production stage, designs on the basis of styling studies often show visions that can only be realised in the distant future.

More colour

Conventional lamps often show the colours of their signal functions: red, amber and white even when they are not lit. By using colour filter technologies, a wide range of colour effects can be achieved that deviate from these signal colours.

Intelligent Signal System INSIGNIS

Adaptive signal lighting

The current signal image on our vehicles is static to a large extent. In other words, the signals always have the same luminous intensity no matter what environmental brightness, weather and visibility conditions are like. Special hazard situations such as a emergency stop are not indicated. The most important tasks for a future signal image on the vehicle are:

- to guarantee visibility and perception of all signal functions in a wide range of different conditions of brightness, weather and visibility and
- to distinguish hazardous driving situations by means of signals different from the ones given in standard situations.

There are three parameters decisive for the achievement of this aim:

- Compatibility with the current signal image
- Clear recognition and assignment
- Automatic switching

Taking the wide range of suggestions and the current status of discussion in the registration bodies into consideration, the following sequence can be expected in the next few years:

1. Continual luminous intensity level for brake light and indicator light
2. Dynamic braking signal (DBS)
   - Normal brightness/normal signal field: → standard braking procedure
   - Double signal area or double the brightness: → increased braking pressure
   - Rapid flashing at top brightness: → hazard braking

Demonstration of the different levels for the dynamic braking signal (DBS)

3. Continual luminous intensity level for all signal functions (incl. tail light). Introducing this adverse weather tail light makes the rear fog lamp (with all its current misuse) superfluous.

Outlook

The highly imaginative use of all the possibilities of the physics of light is at the core of our development work. A technical lighting concept adapted to the function required, taking stylistic matters into account and a design suitable for production from an economical point of view must be brought into line when developing vehicle lamps. In addition, the adaptability possibilities of the human eye has to be taken into account. This is the only way to show off vehicle signal lighting in the desired way.

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