# IMPLEMENTATION OF DAY RUNNING LIGHTS SYSTEM IN OLD CARS WITHOUT CHANGING THE HEADLIGHTS

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**Rezumat.** *Lucrarea de față prezintă sistemul de iluminare la autoturisme în general, istoricul şi evoluția sa. Începând cu anul 2009, luminile de conducere pe timp de zi au devenit obligatorii în Uniunea Europeană, în concluzie toți producătorii de autoturisme sunt obligați să echipeze noile autoturisme cu proiectoare de lumini de zi. În urma studiilor efectuate, s-a stabilit că autoturismele echipate cu lumini de zi prezintă un risc de accidente frontale şi laterale cu aproape 15% mai mic. De asemenea, se va prezenta un modul universal de lumini de zi care se poate implementa foarte uşor la autoturismele care nu au în dotare asemenea lumini.*

**Abstract.** *This paper presents the lighting system of cars in general, its history and evolution. Since 2009, the mandatory use of day running lights (DRL) was introduced in UE regulations therefore all car manufacturers are compelled to equip all brands of new cars with this type of lights. After many studies were carried out, it was proven that DRL reduce frontal and side crashes by almost 15%. An innovative electric module that implements DRL in old cars' illumination system without changing the headlights will be also presented.*

**Keywords:** day running lights, headlight, halogen bulb, relay, module, automatic.

## 1. History

Over the time, with the evolution of cars, the lighting system has also evolved.

The headlights on the very first cars were fuelled with petrol or acetylene (similar to what is shown in Figure 1); this kind of headlights were preferred in the 1880's, because they were windproof and rainproof.

**Fig. 1.** Acetylene headlight.

**Fig. 2.** Bilux type bulb.

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The first electric headlights were introduced in 1898, and were optional. The electric headlight lot production was limited by two factors: short lifespan of filaments and size of the power generator (it was difficult to make such a small dynamo that could fit its established place under the bonnet of the car, and be able to produce enough power).

Mass production of electric headlights began in 1912, going to a new stage, that of modern lighting systems.

In 1915, low / high beam lighting system was introduced, but the initial solution was rather a mechanical one; the headlight had a flap inside that switches between the low and high beam, and the flap was actuated by a lever situated inside the car. This type of system is used even today at some projector type headlights, but is electrically actuated.

Only in 1912, did tungsten bilux bulbs appear, with a filament and a small deflector for the low beam and another filament for the high beam (as can be seen in Fig. 2).

Halogen bulbs were introduced in 1962; they were designed to perfectly replace the existing tungsten bulbs. In Figure 3, a bilux tungsten bulb H4 type can be seen, designed to replace a bilux P45 tungsten bulb.

**Fig. 3.** H4 / P45 halogen bulb.

**Fig. 4.** HID lamp.

**Fig. 5.** HID projector.

Late in the 1990's, high intensity discharge (HID) bulbs appeared, known as xenon bulbs, designed to operate inside projector type headlights, whose size is much smaller than conventional headlights.

The advantages of these bulbs are: more light output (three times more than halogen), longer lifespan (five times more than halogen), and less power consumption (almost half compared to halogen).

In Figures 4 and 5 a HID bulb and a projector type headlight can be seen.

Due to the rapid development of LED technology over these last eight years, the trend is of replacing halogen bulbs with HID and LED bulbs. Nevertheless over the last three years, car manufacturers complemented LED headlights with laser devices, especially high beam, which basically doubles the beam pattern.

## 2. Light Sources

In the automotive industry, six types of lamps are used.

Tungsten lamp

This bulb is a classic filament lamp that lights up into an evacuated bulb of glass. Compared to modern lamps, filament bulbs generate a small quantity of light and a lot of heat at the same power consumption.

Halogen lamp

Tungsten – halogen technology, or quartz – halogen, quartz – iodine, cycle – iodine increases the efficiency of the filament which operates at higher temperatures and produces a lumen output per watt consumed better than the classic filament lamp, having a superior lifespan too.

Halogen infrared reflection lamp

Developing halogen lamps, this type of bulb was obtained, where a second glass bulb covers the halogen bulb, reflecting infrared radiation and helps filament burn at higher temperatures; the bulb produces a light flow per watt bigger than the halogen bulb.

**Fig. 6.** HIR lamp.

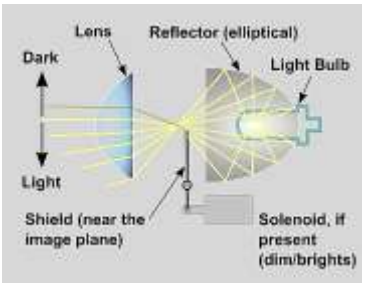


**Fig. 7.** Projector type headlight geometry.

**Fig. 8.** LED bulb CREE type.

High intensity discharge lamp

High intensity discharge lamp (HID) produces luminous flow through an electric arc discharged in an evacuated glass bulb that is filled with a xenon gas.

Compared to a halogen lamp, HID bulb consumes 45% less power, from 5.5 amps to 3 amps for instance, and produces almost three times more light.

Another advantage is a longer lifespan.

As disadvantages we can cite: special geometry of headlight (see Figure 7), and the lamp must be fed with high voltage power supply, hence it needs a special electronic module.

LED lamp

Over the past years, light emitting diodes (LED) technology gained ground, they became smaller and smaller, more advanced from light flow and power consumption point of view.

The advantages of using LED bulbs are: small power consumption and high lifespan.

Disadvantages: projector type headlights have other geometry, it's even smaller than the HID projector, and at least two projectors are required for one headlight.

An example of a LED bulb can be seen in Figure 8.

Laser lamps

Low beam LED headlights are very efficient, but high beam LED headlights are still poor, car manufacturers improve them with Laser devices, such that beam pattern has double length, resulting a much better visibility during the night.

### Output comparison between bulbs

In the next table a comparison between bulbs can be seen, in terms of luminous flow, power consumption and lifespan.

**Table 1. Bulbs output**

| *Bulb type* | *Power consumption* <W> | *Luminous flow* <lm> | *Lifespan* <h> |
|---|---|---|---|
| Tungsten | 45 | 700 | 8,000 |
| Halogen | 65 | 1,300 | 20,000 |
| HIR | 65 | 1,900 | 15,000 |
| HID | 35 | 2,800 | 100,000 |
| LED | 20 | 200 | 50,000 |

## 3. Lighting System Diagrams

For reasons of headlights conformation or manufacturing costs, the manufacturer can choose that headlight design be with a double filament bulb or two bulbs single filament, separate for low and high beam.

Double filament bulb diagram

This diagram uses H4 type bulbs, double filament bulbs or double LED bulbs.

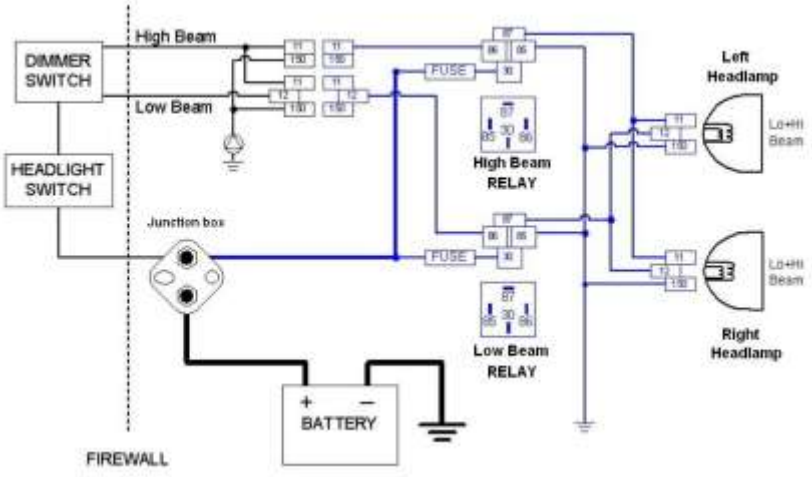


**Fig. 9.** Lighting system with double filament bulb diagram.

The bulbs are powered through relays (one for each beam), used for lights switch protection.

Two single filament bulbs diagram

This diagram uses single filament bulbs, one for each beam.

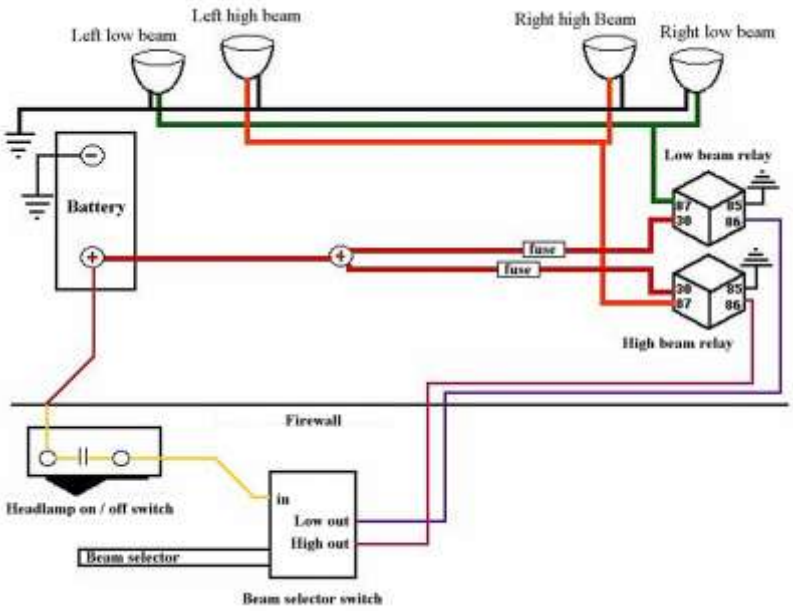


**Fig. 10.** Lighting system with single filament bulb diagram.

There is a bulb for each beam and lights switch is protected by relays, like in the previous diagram.

The advantage of this diagram is that the low beam pattern is more accurate.

## 4. Day Running Lights

The mandatory use of day running lights in the European Union was introduced in 2009, and cars manufacturers started to equip new models since 2011. Actually, starting with 2006, all drivers in the EU had had to drive with headlights switched on even during day time, regardless of the weather conditions. This fact creates disadvantages too, shorter lifespan of low beam and parking lights bulbs, and another aspect is that during the night, when a whole bulb performance is needed, bulbs are already smoked or even blown. Thus, the necessity emerged of fitting new projectors that light up when the engine is running and switch off when the engine stops or parking lights are on. The new lights called Day Running Lights (DRL) must be fitted in front of the car, at a minimum height of 25 cm from ground and 60 cm between them, and they should be powerful enough to be seen in daylight traffic, but not to glare drivers from incoming traffic. Cars manufacturers concluded that D.R.L. bulbs must have 21 W or 400 lumens. Some cars manufacturers replaced the DRL projectors with some LEDs.

The best thing achieved after this law came into force in Europe is the decrease of frontal and side crashes by 15 percent.

The greatest challenge is retrofitting DRLs at the cars made before 2011, without major modification of the vehicle. Manufacturers of car accessories put on the market different types of DRL projectors, especially with LED technology, but they caused some controversies about legality, and most of them look rather kitsch.

### Universal DRL module

A new diagram of DRL has been designed, helping car owners that need DRLs on their cars, without major modifications or replacing headlights.

The diagram controls existing headlights in the following manner: when the ignition is switched on, the high beam or fog light beams light up, but at half strength, so those 65 watts of a high beam bulb, DRL module gives it only 24 watts when is activated. This module automatically deactivates DRLs when parking lights are switched on, if the driver uses the flash function or the ignition is switched off.

The state table of the module can be seen below.

When installed, the module looks like a small box (similar with that in Figure 11) which can be fitted behind the left headlight, whose wiring is going to be modified.

| ignition | parkers / flashes | DRL |
|---|---|---|
| ON | OFF | ON |
| | ON | OFF |
| OFF | OFF | OFF |
| | ON | OFF |

**Table 2. State table.**

**Fig. 11.** Universal D.R.L. module.

**Fig. 12.** Car with DRL on (retrofitted).

For cars that use single filament bulbs, the diagram from Figure 13 can be applied:

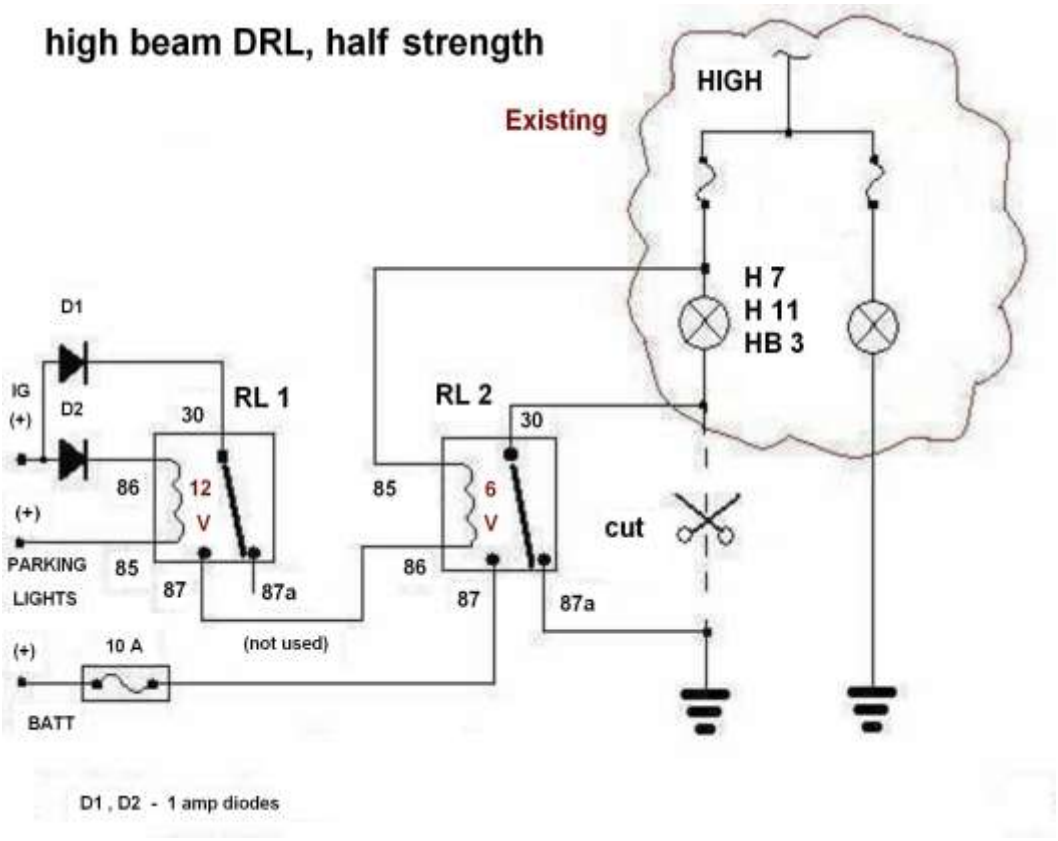


**Fig. 13.** DRL single filament.

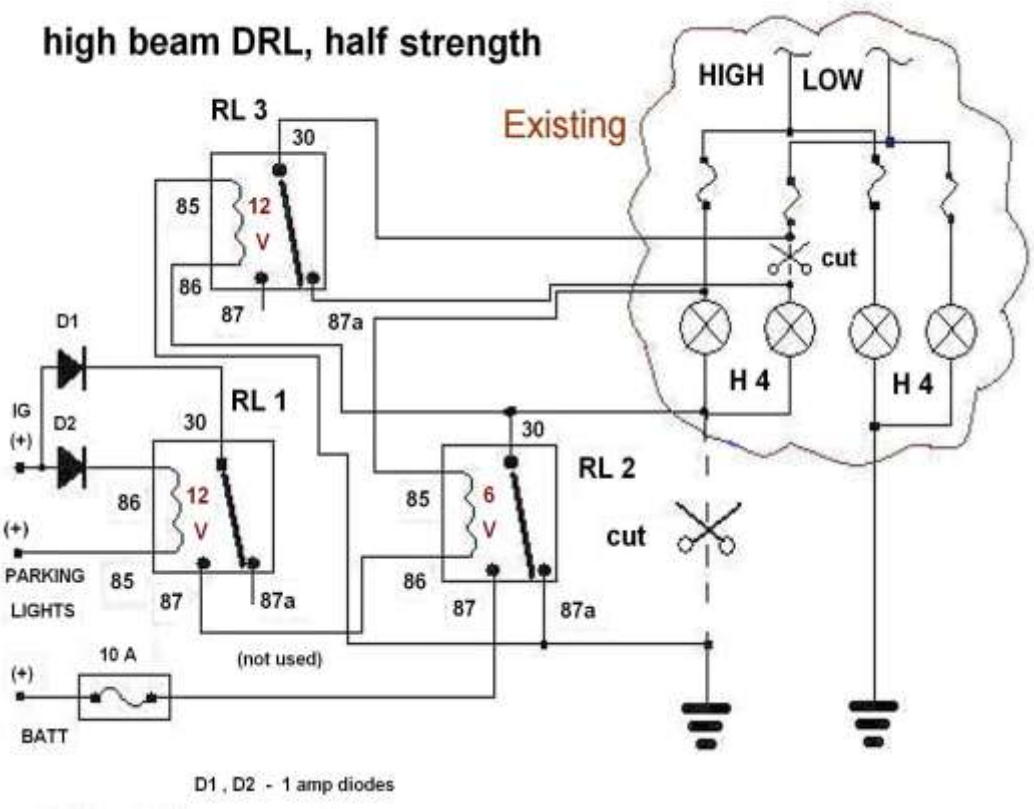


**Fig. 14.** DRL double filament.

Power consumption

Considering that standard power high beam bulbs is of 65 watts each, the total power consumption for both bulbs can be calculated, when DRLs are activated. Measuring the current when DRLs are working, 4 amps are observed on ampere meter. In DRL mode, bulbs are put in series, so each bulb is fed with 6 V.

$I = 4\ A\ ;\ U = 6\ V\ ,\ so\ P = U \times I = 24\ W$ (1)

The total power consumption for both bulbs is:

$\mathbf{P_t =}\ 2 \times P = \mathbf{48\ W}$ (2)

much better than the car is driven with low beam activated, where the total power consumption is:

$\mathbf{P'_t =}\ 2 \times P_b + 4 \times P_p + 2 \times P_n + P_d = \mathbf{170\ W}$ (3)

where $P_b$ = 65 W – low beam bulb power,

$P_p$ = 5 W – parking lights bulb power, $P_n$ = 5 W – number plate light bulb power,

and $P_d$ = 10 W aprox. – dash board illumination power.

The look of a car equipped with this type of module can be seen in Figure 12.

Developing this diagram for vehicles that use double filament bulbs, H4 for instance, the diagram from Figure 14 can be obtained.

An extra relay is needed in order not to activate low beam filaments together with high beam; this relay cuts off the power of low beam filaments in DRL mode.

Cost calculation

The cost of components for this module, without workmanship and labour for fitting on car, is :

$$Ct = 3 \times Cr + 3 \times Cc + 2 \times Cd + Cf + Cb \quad (4)$$

where $C_t$ is product total cost, $C_r$ = 1 € – relay price, $C_c$ = 0.5 € – relay connector price, $C_d$ = 0.25 € – diode price, $C_f$ = 0.5 € – fuse socket (with fuse) price and $C_b$ = 1.5 € – module box price; thus, $\mathbf{C_t = 7\ €}$ (5)

For module whose diagram is shown in Fig. 13, $\mathbf{C_t = 5.5\ €}$ (6)

This modules fitted on a car saves fuel, light bulbs and prevents forgetting the lights on.

## 5. Conclusions

Like any functional system on a car, the lighting system has a considerable evolution. There are many criteria for car designers, to choose such or such type of illumination system, the most important being car prices, climate in the market area, where a determinant factor is the presence of fog, and not least market demand.

The mandatory driving during the daytime with lights on was a very good measure, because this led to a decrease of frontal and side crashes, but the implementation of DRLs was one of the most important factors in road safety.

Owners of vehicles made before 2009 have to choose between driving during daytime with lights on, or they can equip their cars with DRL projectors. Helping them, this module adds DRL function to the existing headlights, without modifying optical blocks or putting additional projectors at minimum costs.

# R E F E R E N C E S

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