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

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Rezumat. Lucrarea de faţă prezintă sistemul de iluminare la autoturisme în general, istoricul şi evoluţia sa. Începând cu anul 2009, luminile de conducere pe timp de zi au devenit obligatorii în Uniunea Europeană, in concluzie toţi producătorii de autoturisme sunt obligaţi 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 work presents cars lighting system, history and evolution. Since 2009, obligativity of day running lights (DRL) have been introduced in UE regulations, therefore all car manufacturers are compelled to equip all brand new cars with this type of lights. After the studies were carried out, DRL reduces frontal and lateral crashes with about 15%. An innovative electric module that implements DRL function in old cars illumination system without changing the headlights will be presented hereby.

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

1. History

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

The headlights at very first cars have been fueled with petrol or acetylene (similar to that in figure 1); this kind of headlights have been preferred in 1880's, because they were windproof and rainproof.

Fig.1. Acetylene headlight

Fig.2. Bilux type bulb

First electric headlights have been introduced in 1898, and they were optionally. Electric headlights lot production has been limited by two factors: short lifespan of filaments and size of the power generator (it was difficult to make such a small dynamo that can fit it's designated place under the bonnet of the car, and be able to produce power enough).

In 1912, mass production of electric headlights has begun, going to a new stage, modern lighting systems.

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

Barely in 1912, tungsten bilux bulbs appeared, with a filament and a small deflector for low beam and another filament for high beam (can be seen in fig.2).

Halogen bulbs have been introduced in 1962; they were designed to replace perfectly 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

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

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 than halogen).

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

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

2. Light sources

In automotive, six types of lamps are used.
Tungsten lamp

This bulb is a classic filament lamp that light up into an evacuated bulb of glass. Comparing with 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 filament efficiency that operates at higher temperatures and produces a lumen output per watt consumed better than classic filament lamp, having a superior lifespan too.

Halogen infrared reflection lamp

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

Fig.6. HIR lamp

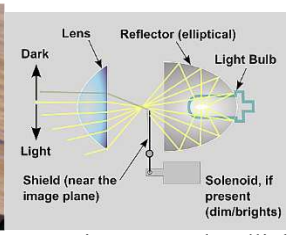

Fig.7. Projector type headlight geometry

Fig.8. LED bulb CREE type

High intensity discharge lamp

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

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

Another advantage is longer lifespan.

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

LED lamp

In last years, light emitting diodes (LED) technology took amplitude, they became smaller and smaller, more advanced from light flow and power consumption point of view.
Advantages using the LED bulbs: small power consumption and high lifespan.
Disadvantages: projector type headlights have other geometry, it's even smaller than 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 still are poor, car manufacturers improve them with Laser devices, such that beam pattern has double length, resulting a much better visibility during night time.

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 to 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.

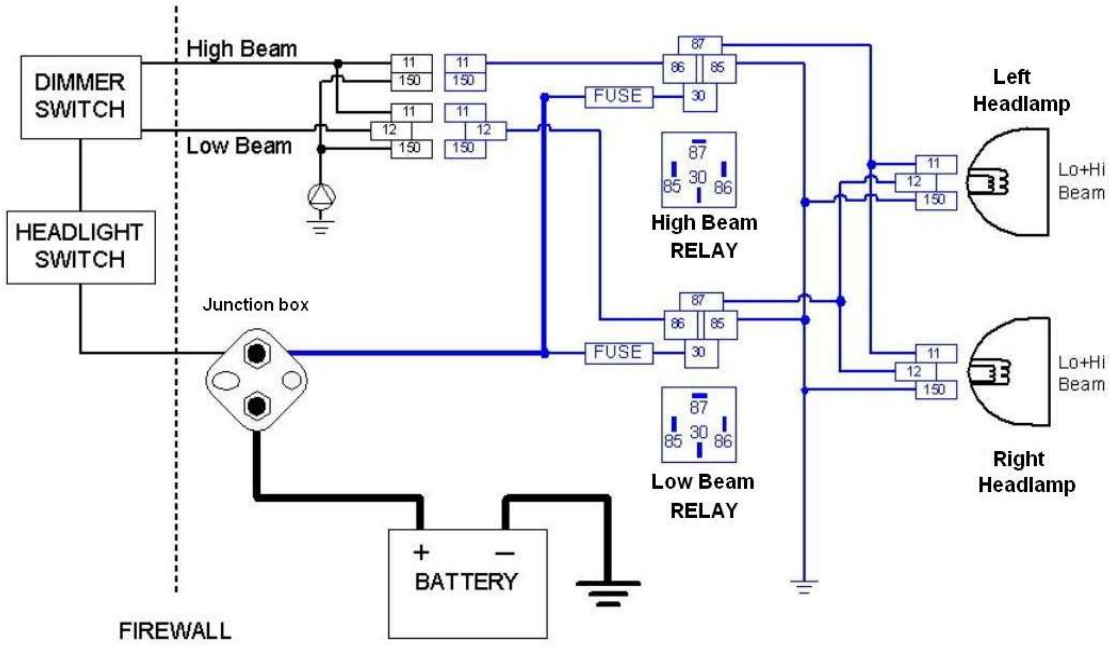

Fig.9. Lighting system with double filament bulb diagram

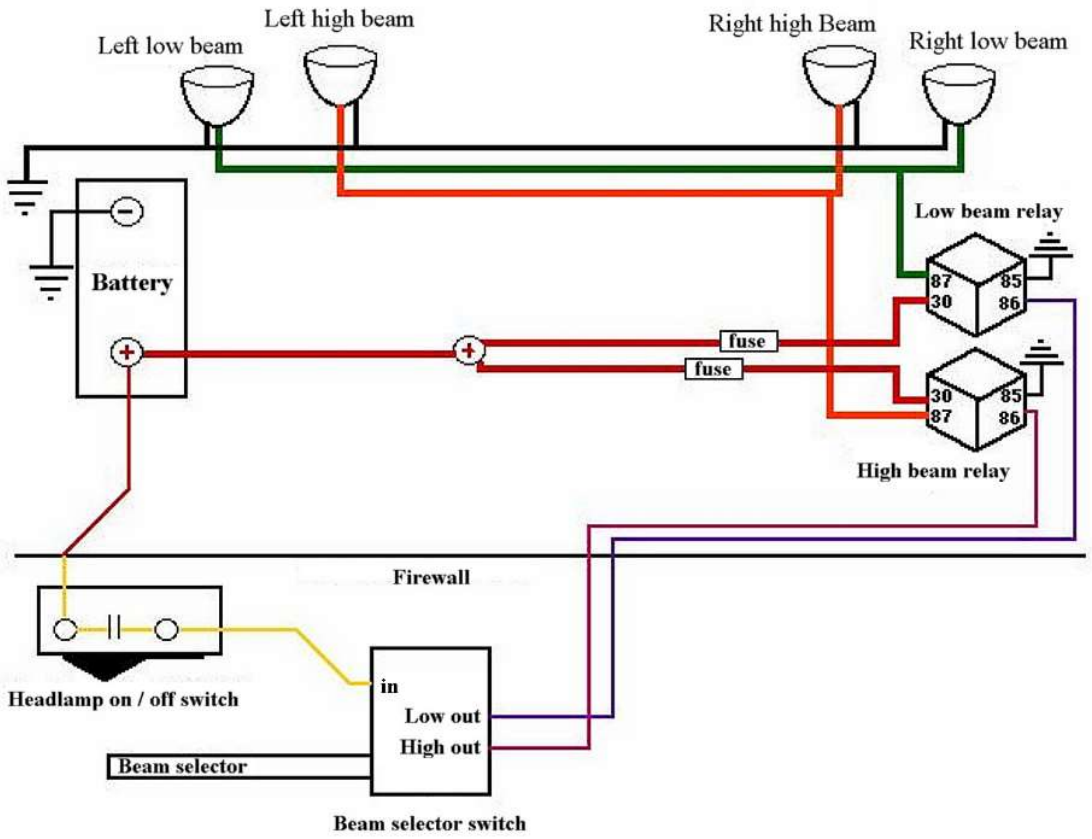

Fig.10. Lighting system with single filament bulb diagram

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

Two single filament bulbs diagram:

Table 2. State table

Ignition	Parkers / flashes	DRL
ON	OFF	ON
	ON	OFF
OFF	OFF	OFF
	ON	OFF

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

There is a bulb for each beam and lights switch is protected by relays, like in previous diagram.
Advantage of this diagram is that low beam pattern is more acurate .

4. Day Running Lights

Obligativity of day running lights in European Union, have been introduced in 2009, and cars manufacturers started to equip new models since 2011. Actually, starting with 2006, all drivers in EU had have to drive with headlights switched on even during day time, regardless weather conditions. This fact creates disadvantages too, shorter lifespan of low beam and parking lights bulbs, and another aspect is that during the night time, when a whole bulbs performance is needed, bulbs are already smoked, or even blown. Thus, it emerged the necessity of fitting new projectors that light up when engine is running and switch off whether engine stops or parking lights are started. The new lights called Day Running Lights (D.R.L.), must be fitted in front of the car, at a minimum hight 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 implemented this law in Europe, is decreasing of frontal and lateral crashes with up to 15 percent.
The biggest challenge is retrofitting DRLs at cars made before 2011, without major modification of vehicle. Car accessories manufacturers put on market different types of DRL projectors, especially with LED technology, but they arise some controversies about legality, and most of them are looking like a kitsch.

Universal DRL module

A new diagram of DRL has been designed, helping the car owners that need DRLs on their cars, without major modifications or replacing headlights.
The diagram controls existing headlights in following manner: when ignition is switched on, high beam or fog light beams lights up, but at half strength, so of 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 driver uses flash function or ignition is switched off.
State table of the module, can be seen below.
Put in opera, 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.

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

Fig.12. Car with DRL on (retrofitted)

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

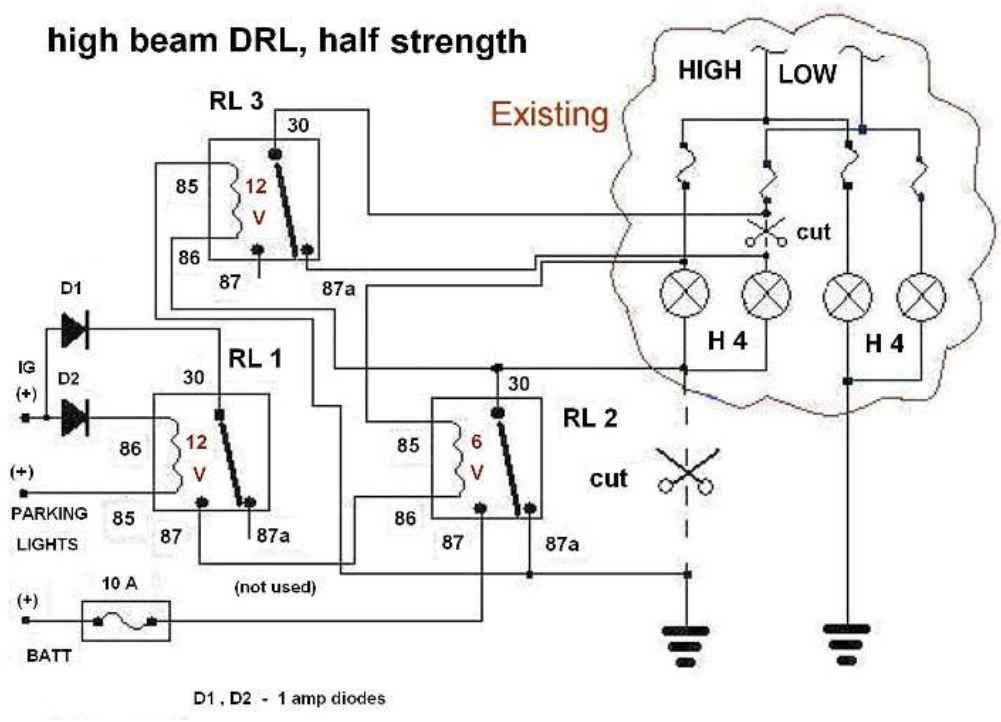

Fig.13. DRL single filament

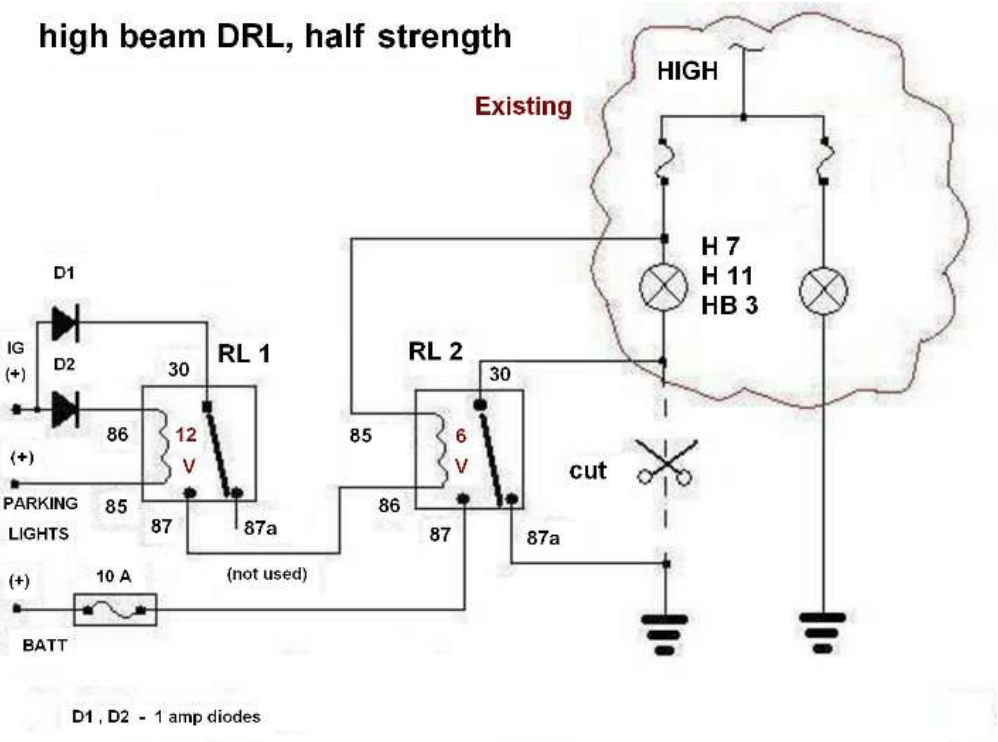

Fig.14. DRL double filament

Power consumption

Considering that standard power high beam bulbs is 65 watts each, 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 this 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)

Total power consumption for both bulbs is:

$Pt = 2 \times P = 48$ W (2)

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

$P't = 2 \times Pb + 4 \times Pp + 2 \times Pn + Pd = 170$ W (3)

where $Pb = 65$ W – low beam bulb power,
$Pp = 5$ W – parking lights bulb power, $Pn = 5$ W – number plate light bulb power,
and $Pd = 10$ 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, diagram from figure 14 can be obtained.
An extra relay is needed in order to not 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 Ct is product total cost, $Cr = 1$ € – relay price, $Cc = 0.5$ € – relay connector price, $Cd = 0.25$ € – diode price, $Cf = 0.5$ € – fuse soket (with fuse) price and
$Cb = 1.5$ € – module box price;

thus, $Ct = 7$ € (5)
For module whose diagram is shown in fig.13,
$Ct = 5.5$ € (6)
This modules fitted on a car saves fuel, light bulbs and prevents forgetting the lights on.

5. Conclusion

Like any functional system from a car, lighting system has a dramatic evolution. There are many criteria for car designers, for choosing a type of an illumination system, the most important are cars price, climate in market area, where a determinant factor is presence of fog, and not in the last market demand.
Obligativity of driving during the day time with lights on, was a very good action, because this led to decreasing frontal and lateral crashes, but implementation of DRLs was one of the most important factor in road safety.
Owners of vehicles made before 2009 have to choose between driving during day time with lights on, or they can equip their cars with DRL projectors. Helping them, this module adds DRL function to existing headlight, without modifying optical blocks or attaching additional projectors.

REFERENCES

[1] https://en.wikipedia.org/wiki/Headlamp , accessed at: 09.03.2016
[2].http://www.politisti.ro/forums/topic/1078-luminile-permanente-de-zi-daytime-running-lights-drl/ , accessed at: 09.03.2016
[3]. http://toyota-corolla.ru/rm04f1ru/ewd/index.html , accessed at: 09.03.2016
[4].http://www.toyotaownersclub.com/forums/topic/117353-drl-on-high-beam/, accessed at: 09.03.16
[5]. http://www.ripper1.com/tech/wiring.php , accessed at: 09.03.2016
[6]. http://www.ripper1.com/tech/wiring.php , accessed at: 09.03.2016
[7]. http://www.osram.com/osram_com/products/lamps/ , accessed at: 09.03.2016
[8]. http://www.philips.ro/e/car-lights/home.html , accessed at: 09.03.2016