

Vehicle Lighting System

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Introduction

A vehicle has lighting to illuminate the road and surroundings ahead to increase visibility for driver to see presence of obstacles, pedestrians, path of travel. Additionally, vehicle has lights to signal, warn, alert drivers of other vehicles and pedestrians of direction of the vehicle, seek priority of movement from other vehicles and other indications such as stop. Lighting system is very important in a vehicle from the perspective of safety of occupants of vehicle and road users and infrastructure. A vehicle has lights placed outside the vehicle (external lights) and lights inside vehicle (internal lights). This document provides details of all the lights of a vehicle and details of how each of these lights are controlled.

Terms, Definitions, Abbreviations

Term	Description
EMI	Electro Magnetic Interference
DRL	Daylight Running Light
CHMSL	Center High Mount Stop Lamp
LD	Lane Departure
AFS	Adaptive Frontlight System

Requirements

Following are the requirements of lights in an automobile

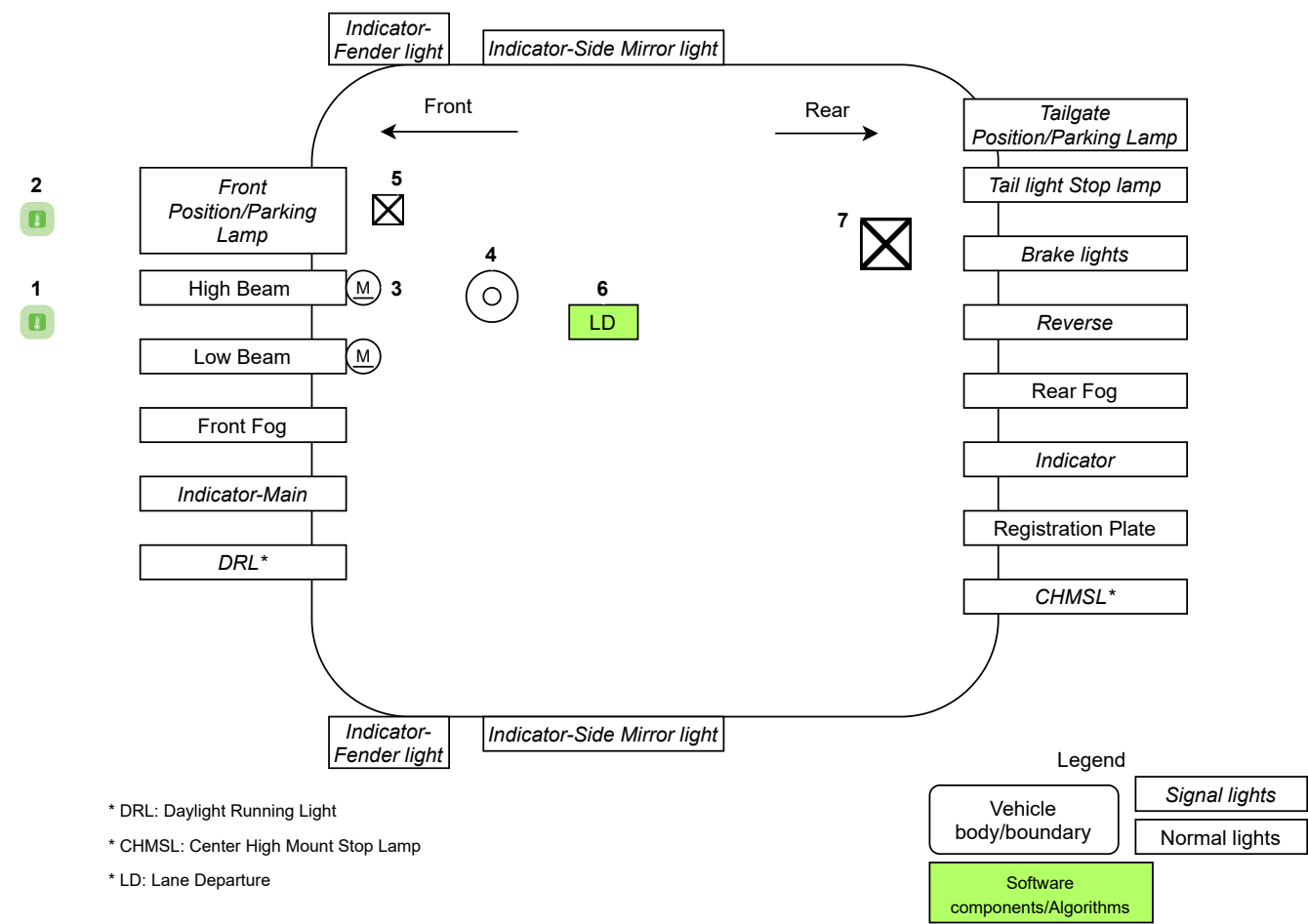
- Reduction of EMI
- Need to operate in cold and hot temperatures
- Durability
- Optimal energy consumption
- Regulations

External Light System

Purpose

- Ensure safety in road traffic and conditions
- Illuminate the lane and enables driver to recognize the road, obstacles and traffic signs
- Road users and others to perceive the presence of vehicle
- Road users and others to recognize intention of driver

External lights and controls



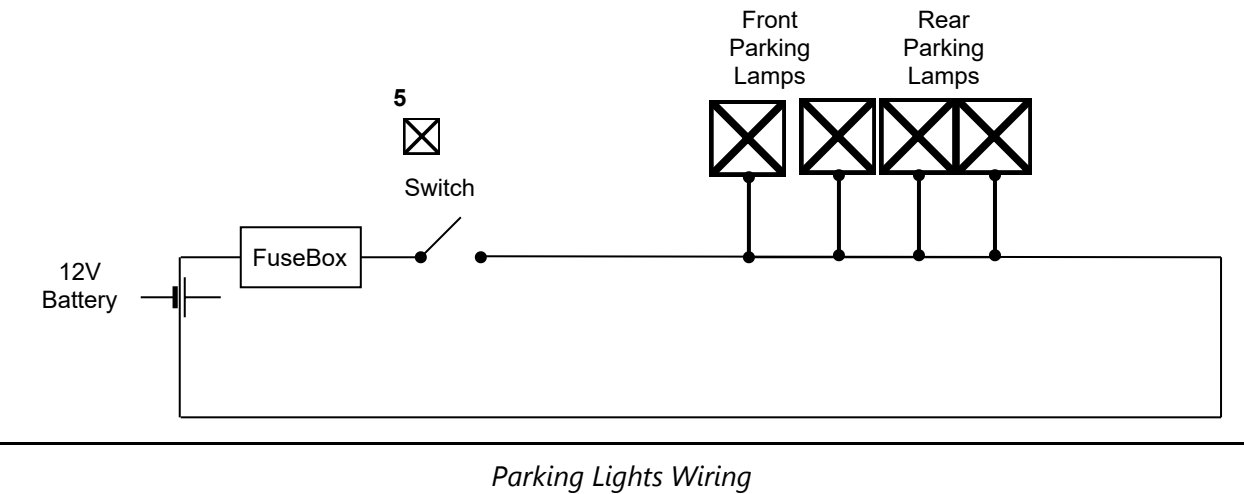
External Lights in a Vehicle

Front Position/Parking Lamp and Tailgate Position/Parking Lamp

These lamps/lights are also called side lights. These lights are used to increase visibility of the vehicle when it is parked.

These lights are triggered using a switch shown as (5) in the diagram.

Parking lamps are connected through simple physical electrical wiring and a switch. This is shown in the diagram below.



```
sequenceDiagram
    autonumber
    actor Driver
    participant Switch
    participant FrontPositionLamps
    Driver->>Switch: Turns on
    Switch->>FrontPositionLamps: Signal to turn on
```

Indicator - side mirror and Fender lamps

Side mirror and Fender lamps are triggered by the following

Hardware: Turn signal lever is activated to indicate direction - left or Right Software Triggered: When lane departure is detected on the left side or right side

These lamps are deactivated when turn signal lever is brought to normal position or lane transition completion is detected

High Beam, Low Beam Lamps

High beam lamps are of low intensity and illuminate a shorter distance in front of the vehicle. Low beam lamps are of high intensity and illuminate greater distance.

Switching between high and low beam is by manual trigger by the driver.

```
sequenceDiagram
autonumber
actor Driver
participant SwitchTrigger
participant HighBeamLamps
participant LowBeamLamps
Driver->>SwitchTrigger: ToggleTrigger
SwitchTrigger-->>HighBeamLamps: Trigger
HighBeamLamps->>LowBeamLamps: Change
```

```
sequenceDiagram
autonumber
actor Driver
participant SwitchTrigger
participant LowBeamLamps
participant HighBeamLamps
Driver->>SwitchTrigger: ToggleTrigger
SwitchTrigger-->>LowBeamLamps: Trigger
LowBeamLamps->>HighBeamLamps: Change
```

Adaptive Front Light system (AFS)

```
sequenceDiagram
autonumber
actor Driver
participant SteeringWheel
participant WheelModule
participant FrontLightModule
participant FrontLightMotor
Driver->>SteeringWheel: Turns
SteeringWheel-->>FrontLightModule: Angle Of Rotation (over CAN)
WheelModule-->>FrontLightModule: Angle Of Rotation (over CAN)
FrontLightModule->>FrontLightMotor: Start rotating Lamp (Angle)
```

Fog - Front, Rear

Brake lights

Reverse light

Registration Plate light

Daylight Running lights (DRL)

Center High Mount Stop Lamp (CHMSL)

Hardware and Software for Vehicle Lighting system

Software

Product Name	Vendor/Open Source	Purpose	Description
Lucidshape	Synopsis	Simulate and Evaluate automotive headlamps	Night driving simulation software Based on CATIA CAD tool

Automotive Lighting: Ecosystem

```
mindmap
  root((AutomotiveLights))
    Lamp manufacturers
      OSRAM[OSRAM]
      Hella[Hella]
    Software
      Simulation Software vendors
        Synopsis[Synopsis]
        OpenSource[OpenSource]
        Freeware[Freeware]
    IC vendors
      xyz
        x
        y
        z
      abc
        a
        b
        c
    XYZ
      x1
      y1
    ABC
      a1
      b1
      c1
```

References

- 1. [Automotive Exterior Lighting by Synopsis](#)
- 2. [Power Supplies for Next-Generation Automotive Lighting by Analog Devices](#)