
TECHNICIAN
TRAINING
DORMAN
Training Seminar Series
Presents:
Commercial Motor Vehicles
"Lighting the Road Ahead"

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DORMAN
Aftermarket Innovators

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Your Instructor For This Webinar

Sulev "Swede" Oun

- **Owner, O&K Truck and Auto Repairs Ltd.**
- **ATTP Master Instructor, New York State**
- **Author, "Medium/Heavy Duty Truck Electricity and Electronics"**
- **Training provider for various Associations, industry and various NY State agencies**
- **Developed trainings that range from four hours to multiple days, specializing in brakes, electrical, regulations and many other subjects relating to our industry.**
- **Member of various organizations such as SAE, CVSA, TANY**

okswede1@aol.com

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What will be covered

- **Brief overview of lighting regulations.**
- **Description and operation of various types of lights and circuits**
- **Diagnosing light issues from simple systems to multiplexed systems.**

4

From last month diagnostic Lunch and Learn

What do you think was going on in the video?

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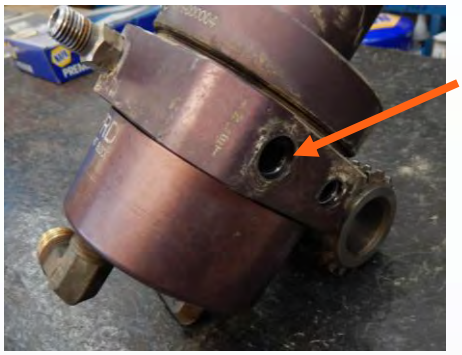

High Pressure gas in

Low pressure Gas out

CNG Pressure Reducing Control Valve

Coolant lines

CNG does not like the cold.

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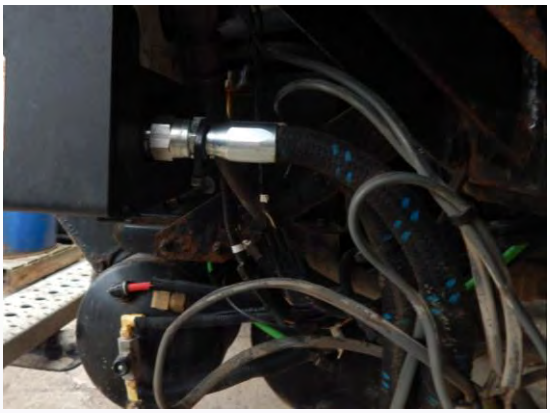

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Lighting Requirements for Commercial Motor Vehicles

Lighting requirements are found in FMCSR's

Part 393- Parts and Accessories Necessary For Safe Operation

- Subpart B- Lamps, Reflective Devices, and electrical wiring
- Starting with 393.9 and ending with 393.30
- References pertaining to lighting are also made in 392 subpart D , "use of lighted lamps and reflectors". 392.33 –obscured lamps or reflective devices/materials.

Part 396- Inspection, Repair and Maintenance directs another path for lighting regulations requirements through:

- Part 396.17 Periodic inspection by stating:

(a) Every commercial motor vehicle must be inspected as required by this section. The inspection must include, at a minimum, the parts and accessories set forth in Appendix G of this subchapter.

Note: These requirements are derived from FMVSS 571.108 Standard.

This standard specifies requirements for original and replacement lamps.

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Lighting Requirements for Commercial Motor Vehicles

Lighting Devices:

Appendix A require all lighting devices required by Part 393 to be operative at all times. The OOS criteria only requires:

- **One stop light and functioning turn signals on the rear most vehicle of a combination vehicle to be operative at all times.**
- **In addition, one operative head lamp and tailight are required during the hours of darkness.**

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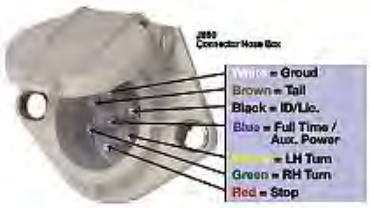
Lighting Requirements for Commercial Motor Vehicles

This is where it starts.

All the trailers' lights are controlled by the towing vehicle. This is the main light connection between the towing vehicle and the towed vehicle. What will happen if this connection is lost?

Example of wire color codes as connected to a nose box, as referenced in regulation SAE J560:



Sulev "Swede" Oun okswede1@aol.com

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Lighting Requirements for Commercial Motor Vehicles

Rear Identification (ID) Lamps
3 red lamps (P2 or P3 rated).
At top center, spaced 6 to 12 inches apart.
May be lower if door header is lower than 25 mm (1 inch).

Rear Clearance Lamp.
2 red lamps (P2, PC*or P3, PC2* rated).
Mounted at- widest point – symmetrically on the rear or near the rear facing rearward.
As high as practicable. (Maybe lower only if ID lamps are at the top.

***photometrically certified at installation angle**

Sulev "Swede" Oun okswede1@aol.com

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Lighting Requirements for Commercial Motor Vehicles

Explanations of ID Codes

P2: Clearance Sidemarker and Identification Lamps

This marking (found on lamps) is currently used for both over 80-inch and under 80-inch vehicles. It seems to be the standard for under 80-inch vehicles. FMVSS 108 have not indicated increased requirements for larger widths. P2 is the minimum standard for clearance, side marker, and identification lights.

P3: Clearance, Sidemarker or Identification lights for use on vehicles over 80- inches wide.

A P3 designated lamp has a higher light output than the P2 rated lamp. It is legal wherever a P2 rated light would be used. Not all manufacturers have made lights to meet the P3 standard.

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Lighting Requirements for Commercial Motor Vehicles

PC : Combination Side Marker and Clearance Lamp or Identification for vehicles over 80-inches wide.

For this PC rated lamp to be used as a combination light, the lights have to be mounted on a 45° bevel at the corner of a vehicle, allowing clearance and side marker functions to be combined in one light.

NOTE: A PC light can be used anywhere a P2 or P3 light would have been used, but the reverse is not true.

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Lighting Requirements for Commercial Motor Vehicles

PC2: Combination Side Marker and Clearance or Identification lights used on a vehicle over 80 inches wide.

PC2 lamps meet an increased angle output and are designed as combination lamps. They must be mounted on a 45° beveled corner, when used as a combination lamp.

NOTE: FMVSS-108 doesn't require these lens markings, with the exception that they accept DOT lettering as certifying legal compliance.

However, companies like Truck-lite engrave their name and SAE/DOT Identification Codes on their lamps. This makes it easy to identify the proper lamp for the application.

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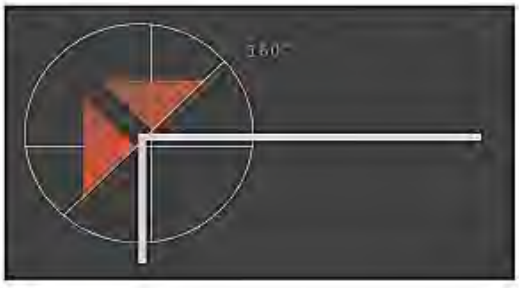
Lighting Requirements for Commercial Motor Vehicles

ILLUSTRATION A - SAE P2 Rated Lamp

- Projects light at a 90° Angle
- Two required, one mounted on each top and front per side as required by FMVSS108

This picture courtesy of Truck-Lite shows that two P2 rated lamps are required in this corner configuration.



That's where Truck-Lite's PC Rated combination lamps provide the perfect solution as shown on the next slide.

Truck-Lite

Falconer, NY USA • Wellsboro, PA USA • Coudersport, PA USA • McElhattan, PA USA • Saline, MI USA
Puebla, Mexico • Minsk, Belarus • Bydgoszcz, Poland • Ebersach, Germany • Harlow, UK • Birmingham, UK

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Lighting Requirements for Commercial Motor Vehicles

These two illustrations show the use of a PC rated lamp.

Can you get it wrong? How can you tell the difference between a P2 and PC?

ILLUSTRATION B - SAE PC Rated Lamp
- Projects light at a 180° Angle
- One required, mounted on top on a 45° radius per side as required by FMVSS108

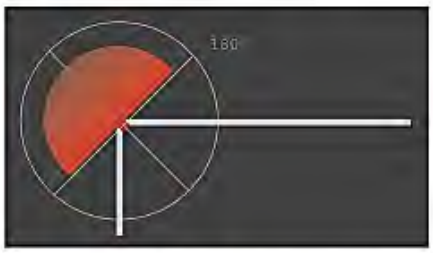
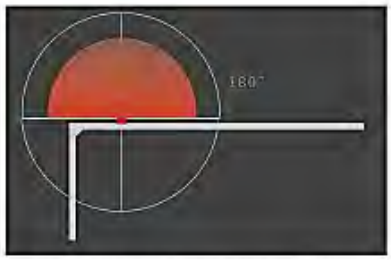


ILLUSTRATION C - SAE PC Rated Lamp
- Projects light at a 180° Angle
- One required, mounted on top side of rail near the corner



Truck-Lite offers a variety of PC rated combination marker clearance lamps to choose from. Please refer to the clearance marker section online at truck-lite.com or a printed catalog.

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Falconer, NY USA • Wellsboro, PA USA • Coudersport, PA USA • McElhattan, PA USA • Saline, MI USA
Puebla, Mexico • Minsk, Belarus • Bydgoszcz, Poland • Ebeneck, Germany • Harlow, UK • Birmingham, UK

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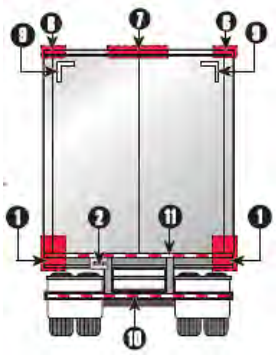
Lighting Requirements for Commercial Motor Vehicles

TRAILERS



1. **Tail Lamps: Minimum 2 Red lamps symmetrically as far as practical. Height from ground, 15-72 inches.**

   Stop Lamps: Minimum 2 Red lamps symmetrically as far apart as practical. Height from ground, 15-72 inches.

2. **Turn Signal Lamps: Minimum 2 "Red or Yellow" lamps symmetrically as far apart as practical. Height from ground, 15-72 inches.**

   License Plate Lamp(s): Minimum 1 white lamp, above or at the sides of license plate. No height requirement.

Sulev "Swede" Oun okswede1@aol.com

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Lighting Requirements for Commercial Motor Vehicles

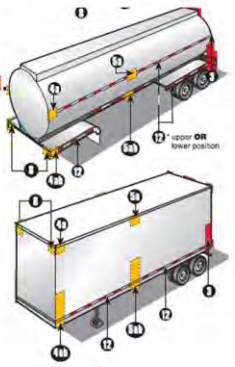
3 **Rear Side Marker Lamps:** Minimum of 2 Red lamps. Each side at rear as far as practicable. Height from ground: 15"-60". "No maximum for 80" wide." SAE lens codes: P2, PC*, or P3, PC2*.

- **Rear Side Reflex Reflectors:** Minimum of 2 Red. Each side at rear as far back as practicable. Height from ground: 15"-60". SAE code A.

4ab a **Front Side Marker Lamps:** Minimum of 2 amber. Each side at front as far forward as practical. Height from ground 15". SAE code:

b P2, PC or P3, PC2.

Front Side Reflex Reflectors: Minimum 2 amber. Each side at front as far forward as practical facing sideward. Height from ground: 15"- 60".



Sulev "Swede" Oun oksweder@aol.com

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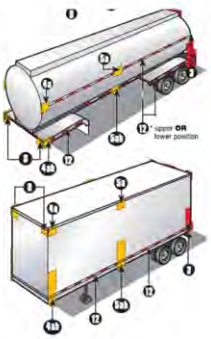
Lighting Requirements for Commercial Motor Vehicles

Additional Equipment For Trailers 30 ft. or Longer.

5ab

a **Intermediate Side Marker Lamps:** Minimum 2 amber on each side near center facing sideward. Height from ground 15"minimum.

b **Intermediate Side Reflex Reflectors: Minimum** 2 amber on each side near center facing sideward. Height from ground 15"- 60". SAE code: A



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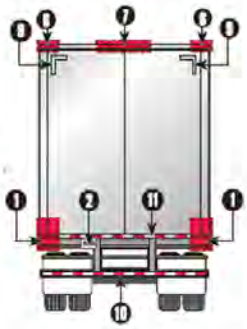
Lighting Requirements for Commercial Motor Vehicles

9 **Rear Upper Body Markings:** Exactly 2 pairs of "white"12-inch-long strips of conspicuity treatment.

10 **Bumper Bar Marking:** Continues Red/White conspicuity treatment, on the bumpers horizontal bar (full width). No height requirement.

11 **Rear Lower Body Marking:** Continues Red/White conspicuity treatment on the rear full width of the vehicle. As horizontal as practical to the range of 14.75-60 inches from the ground.



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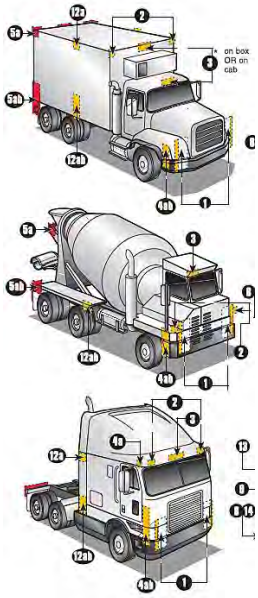
Lighting Requirements for Commercial Motor Vehicles

BASIC EQUIPMENT REQUIRED ON ALL TRUCKS, BUSES & MPVs



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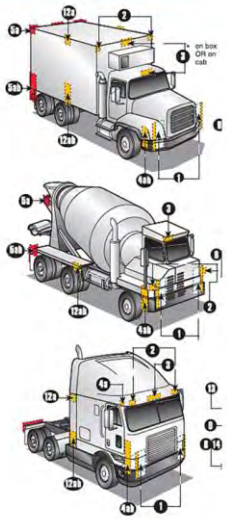
Lighting Requirements for Commercial Motor Vehicles

BASIC EQUIPMENT REQUIRED ON ALL TRUCKS, BUSES & MPVs



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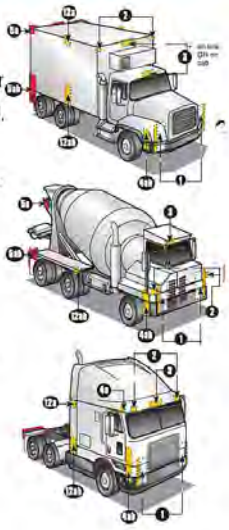
Lighting Requirements for Commercial Motor Vehicles

BASIC EQUIPMENT REQUIRED ON ALL TRUCKS, BUSES & MPVs

5 **a** **Rear Side Marker Lamps:** SAE codes: P2,PC or P3,PC2. Minimum of 2 **RED** lamps are required. Required on each side at rear as far as practicable. Height from the ground is 15 inches minimum.

b **Rear Side Reflex Reflectors:** SAE code: A. Minimum of 2 **RED** required. Required on each side at rear as far back as practicable facing sideward. Height from above ground is 15- 60 inches.



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Typical bulbs that have been around for years.

Warning: Use the right bulb. WATTS, WATTS- AMPS,AMPS!

There are two types of incandescent lighting for transportation industry:
Common to all these is a tungsten filament (glow filament).
Also known as thermal radiators.

Replaceable incandescent bulbs.

Sealed incandescent lighting

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Halogen Lamp also uses a tungsten filament.

- The tungsten filament is encased inside a small quarts envelope.
- Inside the quarts envelope are halogen gases.
- When the bulb is at operating temperature, the halogen gas combines with the tungsten atoms as they vaporize and redeposits them on the filament.
- The filament can run at higher temperatures, making it possible to get more light per unit of energy consumed.

Note: These bulbs produce a lot of heat. Much higher temperatures compared to normal incandescent bulbs.

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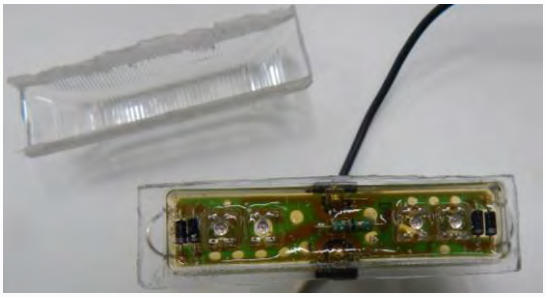
LED (Light Emitting Diodes). **LED's are not about WATTS**

- Electrically charged semi-conductor chip attached to a circuit board and inserted in a lamp housing.

- **These lights have become standard on today's vehicles.**
- Long life and low current- draw makes these ideal for transportation industry.
- **Instantaneous response time (approximately 200 milliseconds faster than an incandescent lamp) creates 18-20 feet of additional stopping distance for trailing vehicles at typical highway speeds.**
- 85% reduction of load on electrical systems.
- **Minimizes voltage drop.**



Electronic components are completely encapsulated within the lamps. Sealed plugs and connectors are used with LED lights.

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Light Emitting Diodes (LED's)

- LED's convert electrical current directly into light (photons)
- **They are highly efficient because there is no heat loss.**
- They consume a fraction of the power of conventional bulbs.
- **They illuminate at faster speeds.**

➢ LED's are used mainly for ***illumination*** and ***indication.***

<u>One disadvantage- Lack of heat makes them more susceptible to ice and snow buildup during winter operation.</u>

➢ **All diodes produce some electrical response when subjected to light.**
- ***Photo diodes* are designed to detect light.**

➢ Electric concepts for LED's
- Resistance affects brightness.
- Voltage affects brightness.

Very important: There is a limit to how much voltage and resistance. Exceeding the limit can destroy the LED. Ohms law at work.
- Typical current tends to be 20ma to possibly 30ma. Per LED.

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NEW from Truck-Lite

Heated LED Lights.

- Heating element to prevent ice and snow buildup.

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Spec's for Truck-Lite heated Super 44 and 60 series LED stop/turn/tail lamps

- 3 and 4 pin integral plug (Amp super seal)
  - 3pin STT, 4 pin STT w/BU
- Voltage 12.8 V
- Current draw with heater on-
  - Tail: 0.55A – 0.65A I Stop: 0.6A – 0.8A I B/U: 0.75A – 1.0A
- Heater is self-regulating
  - Heater is always powered and adjusts output depending on temperature

* PTC base will automatically turn on as temperature drops.

- Polycarbonate lens and housing
- Same light pattern and output as existing product
- Flange or grommet mount available.

*PTC thermistors are often used in LED lighting applications to control the current. This is typically done in the driver circuit.

- Used to protect the LED from overheating.
- Controlling the LED current as a function of temperature.

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PTC

- PTC stands for Positive Temperature Coefficient.
- In a PTC thermistor, resistance increases as its temperature increases.
- They are typically used to protect electronic circuits from high temperatures

NTC

- NTC stands for Negative Temperature Coefficient.
- In a NTC thermistor, resistance decreases as its temperature increase.
- They are used for temperature control and measurement.
- An example of its use is a Engine Coolant Temperature Sensor (ECT).

NICE TO KNOW INFO: Positive Temperature Coefficient (PTC) heaters.

- Used in EV's. When power is applied to a cold PTC heating element, it has a low resistance, drawing a large current. As it heats up, the resistance increases and current draw decreases. The PTC will stop drawing current if it overheats and it only draws the current it needs to maintain temperature.

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- Plug-and-play

Heated Option:

- Heats constantly under 10 C / 50 F
- Unique heat pattern is designed to prevent ice, slush, and snow build up on the lens

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Bulkhead Module (BHM)

- BHM is the primary module of the Freightliner M2 electrical system.
- This BHM controls the operation of the other multiplex modules in their system and a variety of other vehicle components either directly or indirectly.

Awake State and Sleep State

- The Bulkhead Module, Chassis Module (CHM) and instrumentation control unit (ICU) are in an awake state or a sleep state depending on vehicle condition.
- Awaking any of these components will wake up the remaining components up if they are not already awakened.

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Bulkhead Module (BHM)

- **Waking Up**
  - Opening door switch.
  - Turning on hazard switch.
  - Turning ignition switch to any position other than off.
  - Turning on the headlight/parking light switch.
  - Depressing the service brake.
- **Sleep state**
  - The BHM, CHM, and ICU will enter a sleep state when no longer actively controlling any outputs or responding to any inputs and all other power down requirements are met.

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Bulkhead Module (BHM)

- **The following light related components are controlled by BHM:**
  - Dome lamps 6.7 A
  - Left High Beam 6.7 A
  - Left Low Beam 6.7 A
  - Clearance Lamps 6.7 A
  - Tail/License Plate/Trailer Relay 6.7 A

In Blue are the maximum allowable current load for the output pins.

- **What can happen if the amps get exceeded?**
- **How would you read the amps?**

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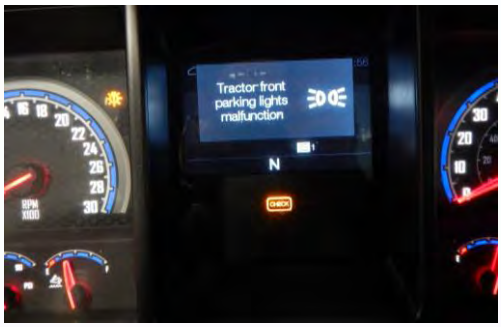

- Display shows park light malfunction.
- Both front markers not working.
- This is a perfect example of controllers used for illuminating lights, recognizing an issue and displaying the issue.
- No relays or fuses.

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- The right-side marker was the culprit.
- Too much amp draw, putting the controller into over current protection mode.
- $140.00 marker replacement on driver side was the fix.
- Both sides work and the controller was happy.

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Chassis Module (CHM)

- The chassis module takes orders from the bulkhead module (BHM).
- This module provides power flow and circuit protection to the various components of the M2 electrical system.
- Also reports its input and output states to the BHM.
- When maximum allowable current load is exceeded, the CHM software will shut off the affected output pin or group of pins.

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Chassis Module (CHM)

- ➢ The following are light related outputs from the chassis module:
- Right Low beam.
- Turn Right Front/Side
- Turn Right Rear
- Right Stop Lamp
- Left Stop Lamp
- Right DRL
- Trailer Turn Right
- Left Park Lamp
- Right Park Lamp
- Left Marker Lamp
- Right Marker Lamp
- Trailer Marker Relay Right High Beam
- Turn Left Front/Side Turn Left rear

➢ These are just some of the components.

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Virtual Fuses and Breakers

- These devices are used in CHM (controllers) circuits.
- They take the place of electromechanical circuit breakers.
- If there is an overload event, the virtual circuit protection device trips without any actual physical action taking place (fuse or circuit breaker).
- Virtual circuit protection devices can be programmed to perform the same as the electromatic counterparts (Cycling and non-cycling).

Field Effect Transistors (FET's)

- FET's are electronic relay switches.
- They are a perfect compliment for circuits with *Smart Switches.*
- They can be used either as a switch or amplifier.
- A positive charge to the gate(base) permits electron flow without any moving parts (Contacts on relay).
- Low current controlling high current.

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Smart Switches

- Utilized in Multiplex systems.
- **These switches are capable of broadcasting switch status onto the data bus.**
- Also known as ladder switches, because they contain a ladder of resistors (usually five per switch).
- **A processor receiving data from the ladder switch has a library of resistor values to identify switch commands and status.**
- A smart switch typically has a LED to indicate that a switch request has been effected.
- **Smart switches can be toggle, multi-position or momentary style.**
- A module broadcasting to the data bus is designed to self-check smart switch operation.

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Smart Switches cont.

- *And* signal a fault if one is detected.

Example: Terminal corrosion (resistance) or loose wire is determined by analyzing the ladder bridge resistances. The system know it and possible locate it.

***Smart* tip:**
Disconnecting a smart switch will log a code immediately. Use the systems self-diagnostics to locate a problem(s).

Let's put it all together!

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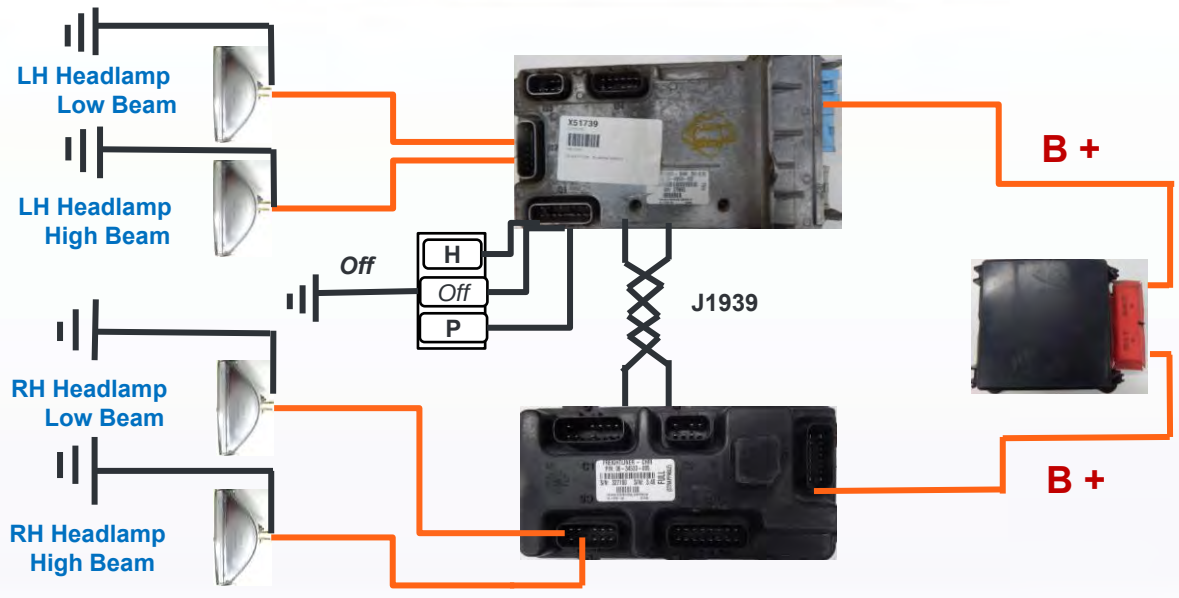

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Example of Bulkhead Module, Chassis Module and Headlight Switch working together:

- When the headlamp switch is turned on, the BHM senses the input.
- The BHM is programmed to know which outputs to activate and where the outputs are located (i.e., BHM,CHM or any other controller.
- In this case, the output for the left headlamp low beam are located on the BHM and the outputs for the right headlamp low beam are located on the CHM.
- The BHM directly activates the left headlamp low beam.
- Because the right headlamp low beam outputs are on the CHM, the BHM sends a message over the J1939 to the CHM to tell it to activate those outputs.
- Once the CHM receives the message, it activates the correct outputs and sends a message back to the BHM reporting the new status of the outputs.

Note: This design allows at least one headlight to work even if one of the modules fails.

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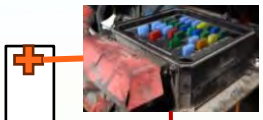
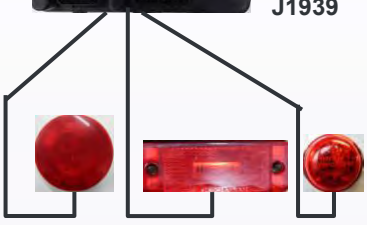
Power Distribution Module (PDM)

- No Relays



Low Current Smart Switches



Multiplexing

- Multiple Control modules communicate with each other.
- Low current switch signals to activate a feature, such as lights in this case.

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"Hard wired" – Fused and Relayed

- This PDM (Power Dist. Module uses fuses and relays.
- This system uses "High Current Switches"
- A "High Current Switch" is a switch in which the power flows through the switch to operate a component such as a light(s).

- Corrosion Control
- Forms a protective thin film barrier to stop oxidation.

Avoiding/Eliminating Light Failures

Minimize Corrosion

- Seal and or use sealed harnesses and connectors.
- Don't poke into wires.
- Use proper gauge wires.
- Don't start truck with lights on. Why??
- Voltages surges!!

Lights do not like under and over voltage.

- Poor grounding. (Dedicated ground through sealed harness is always preferred)

Spaghetti wiring is not uncommon in trucking.

All the above open the door for discussions on best practices.

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Thank You !

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