INTRODUCTION

A vehicle has many different lighting and signaling systems, each with its own specific components and operating characteristics. The major light-related circuits and systems include the following:

- Exterior lighting
- Headlights
- Brake lights
- Turn signals and flasher units
- Courtesy lights

Older vehicles used the headlight switch to operate all the lights, including

- Headlights
- Taillights
- Side-marker lights
- Front parking lights
- Dash lights
- Interior (dome) light(s)

The headlight switch assembly on older vehicles carried a heavy current and was mechanical. Most contained a built-in circuit breaker for circuit protection. Figure 1.

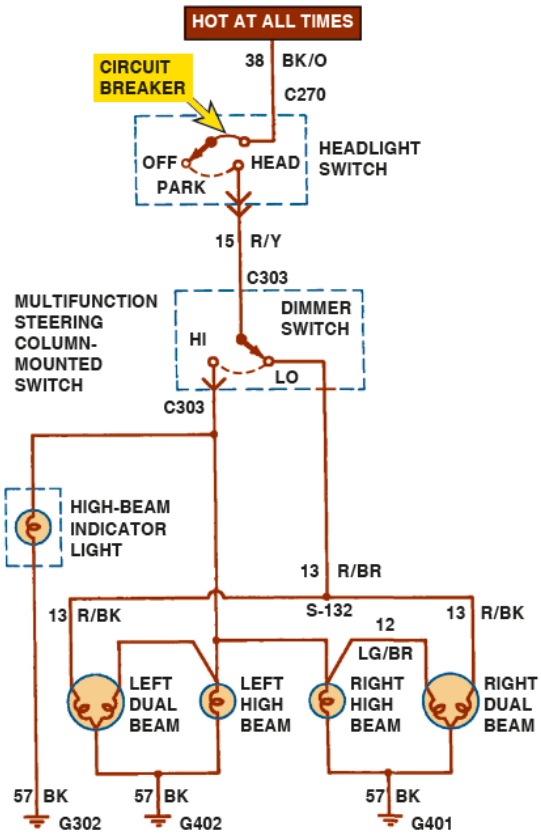

Figure 1. Mechanical headlight schematic (older vehicles).

All recent vehicles use a controller, usually the body control module (BCM), to control the lights. The switches to turn on the lights are simply a request from the switch to the BCM to turn on the lights. The communication between the switches and the BCM is over serial data lines. Many vehicles use front and rear lighting modules, so the BCM sends a message over the data lines to the front or rear lighting module to turn on the commanded lights. Figure 2.

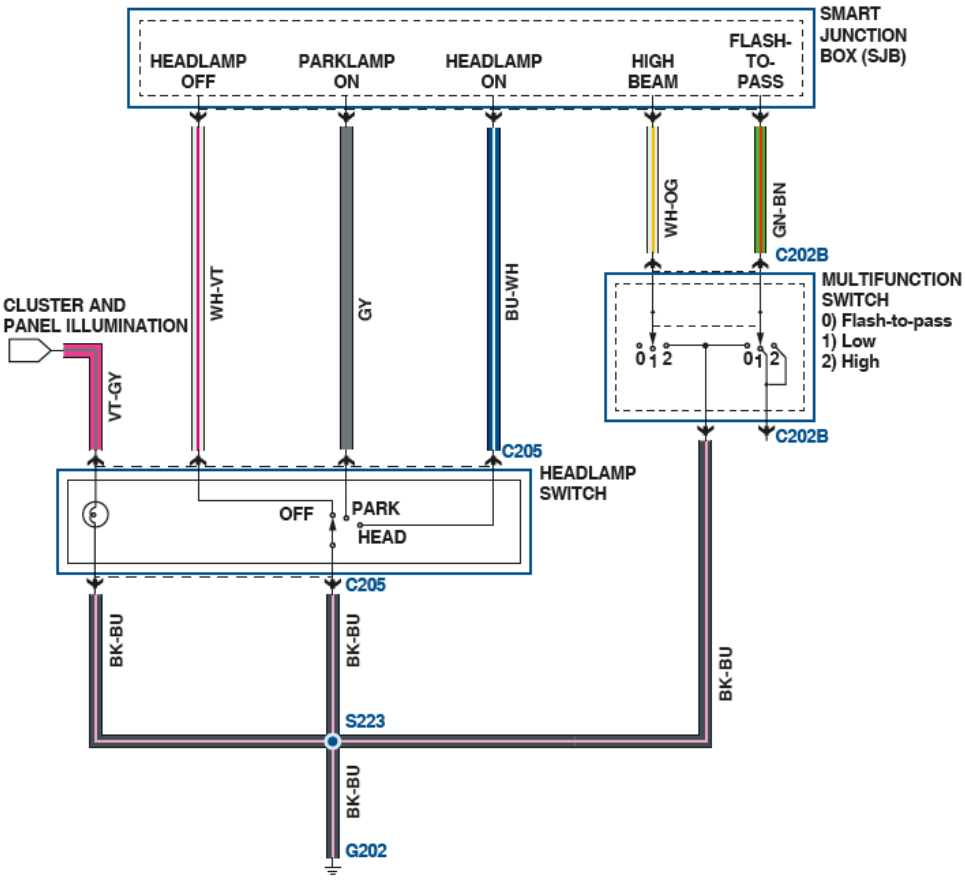

Figure 2. A schematic showing the inputs from the multifunction switch and the headlight switch to the smart junction box (SJB). The SJB then uses the body control module (BCM) to operate the lights.

Sealed beam headlights were used for many years and then, in the 1990s, were replaced with composite headlights. *Composite headlights* are constructed using a replaceable bulb and a fixed lens cover that is part of the vehicle. The replaceable bulbs are usually bright halogen bulbs. Figure 3.

Figure 3. Composite headlight.

High-intensity discharge (HID) headlights produce light that is crisper, clearer, and brighter than light produced by a halogen headlight. HID lamps do not use a filament like conventional electrical bulbs but contain two electrodes about 0.2 inch (5 mm) apart. A high-voltage pulse is sent to the bulb, which arcs across the tips of electrodes, producing light.

The HID lighting system consists of the discharge arc source, igniter, ballast, and headlight assembly. Figure 4.

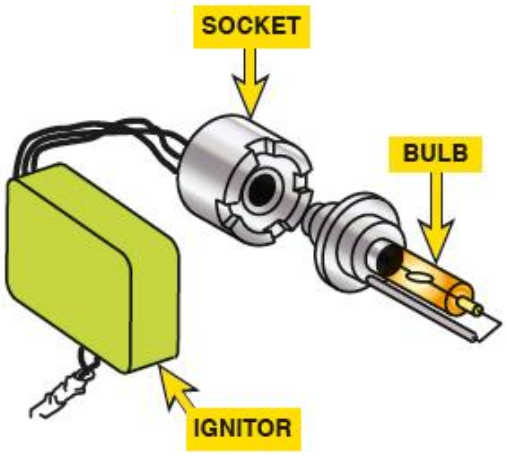

Figure 4. The igniter contains the ballast and transformer needed to provide high-voltage pulses to the arc-tube bulb.

Many newer vehicles use *light emitting diode (LED) headlights* either as standard equipment or optional equipment. Some advantages of LED headlights compared to other types are long service life and reduced electrical power is required. Multiple small LEDs may be required to create the necessary light output. Figure 5.

Figure 5. LED headlights usually require multiple units to provide the needed light.

ASE TEST TOPICS

1. Diagnose the cause of brighter than normal, intermittent, dim, continuous or no operation of exterior lighting; determine needed repairs.

If the headlights are not working at all, perform the following steps:

- Use a factory or factory-level scan tool to turn the headlights on using the bidirectional command from the scan tool. If the headlights work, the headlights, and the headlight circuit are working normally. The problem is likely the control input to the controller that operates the headlights.
- Check the schematic for the headlight circuit and check for voltage at various parts to help pinpoint the location of the open circuit. Always follow the vehicle manufacturer's specified procedures.

If the headlights are brighter than normal, the battery voltage may be higher than normal. Check the charging system voltage to make sure that it is less than 15.5 volts (on most vehicles).

If the headlight(s) is/are dimmer than normal, check the electrical circuits to the headlights for excessive circuit resistance, such as any of the following:

- Loose electrical connector
- Corroded socket
- Poor electrical ground connection

2. Identify, inspect, replace, aim and/or level headlight assemblies and auxiliary light assemblies (fog lights/driving lights), including high-intensity discharge (HID), LED, and advanced front lighting systems.

All headlights, regardless of shape, must be able to be aimed using headlight-aiming equipment. The headlights are equipped with adjusting screws that can be used to aim the headlights. Some are also equipped with a bubble level to help make sure that the lights are level. Figure 6.

Figure 6. Headlight aiming bubble level.

Check service information for the exact procedure and specifications to follow when aiming headlights. Figure 7.

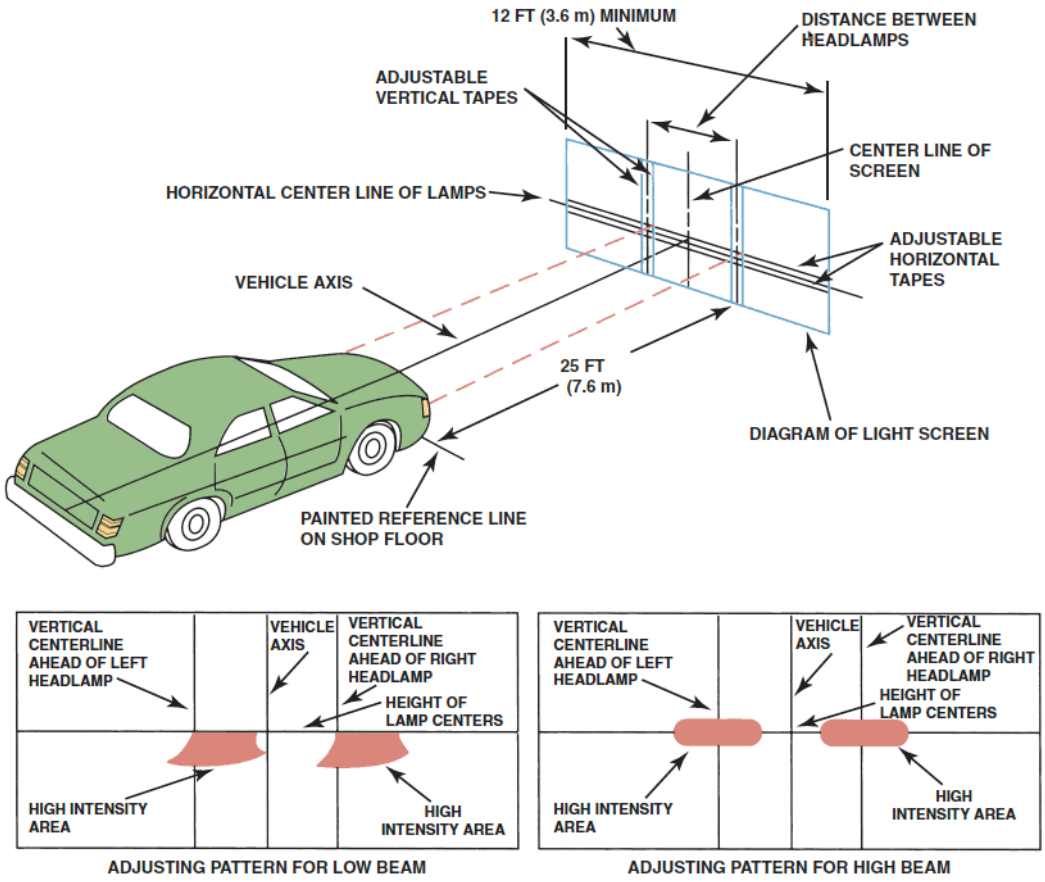

Figure 7. Typical headlight aiming diagram as found in service information. Similar diagrams are available for aiming fog and driving lights.

3. Inspect, test, repair and/or replace switches, relays, bulbs, LEDs, sockets, connectors, terminals, wires, and control modules of exterior lighting.

Bulbs can be tested using an ohmmeter and checking the resistance of the filament(s). Most bulbs read low resistance, between 0.5 and 20 ohms (incandescent bulbs), at room temperature, depending on the bulb. Test results include the following, figure 8:

- Normal resistance . The bulb is good. Check both filaments if it is a two-filament bulb.
- Zero ohms. It is unlikely, but possible for the bulb filament to be shorted.
- OL (electrically open). The reading indicates that the bulb filament is broken.

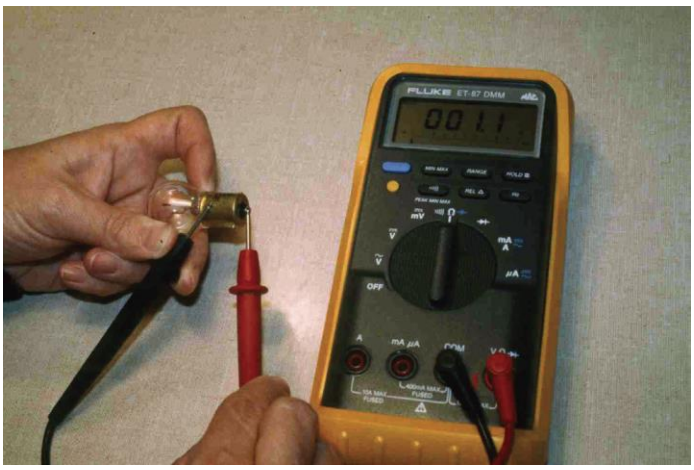

Figure 8. This single-filament bulb is being tested with a digital multimeter set to read resistance in ohms. The reading of 1.1 ohms indicates the filament is good.

The number used on automotive bulbs is called the bulb trade number, as recorded with the American National Standards Institute (ANSI). The number for a particular bulb is the same regardless of the manufacturer. Figure 9.

BULB NUMBER	FILAMENTS	AMPERAGE	WATTAGE
1156	1	2.1	26.9
1157	2	0.6 / 2 .1	8.3 / 26.9
2057	2	0.5 / 2.1	6.9 / 26.9
3057	2	0.5 / 2.1	6.7 / 26.9
4157	2	0.6 / 2.1	8.3 / 26.9

Figure 9. Typical bulb trade numbers and specifications.

LED lights are frequently used in newer vehicles. Aftermarket replacement LED bulbs that are used to replace conventional bulbs may require the use of a different type of flasher unit due to the reduced current draw of the LED bulbs. Figure 10.

Figure 10. A replacement LED taillight bulb is constructed of many small, individual light-emitting diodes.

When replacing halogen bulbs, it is important to never touch the glass of the bulb with bare fingers because the natural oils of the skin on the glass bulb can cause the bulb to break when it heats during normal operation. Figure 11.

Figure 11. Handle a halogen bulb by the base to prevent the skin’s oil from getting on the glass.

4. Diagnose the cause of turn signal and/or hazard light system malfunctions; determine needed repairs.

Turn and hazard light systems can be mechanical-type systems (older vehicles) or operated by the body control module (BCM) and/or lighting modules. Refer to this schematic to find the related components of a mechanical system to check. Figure 12.

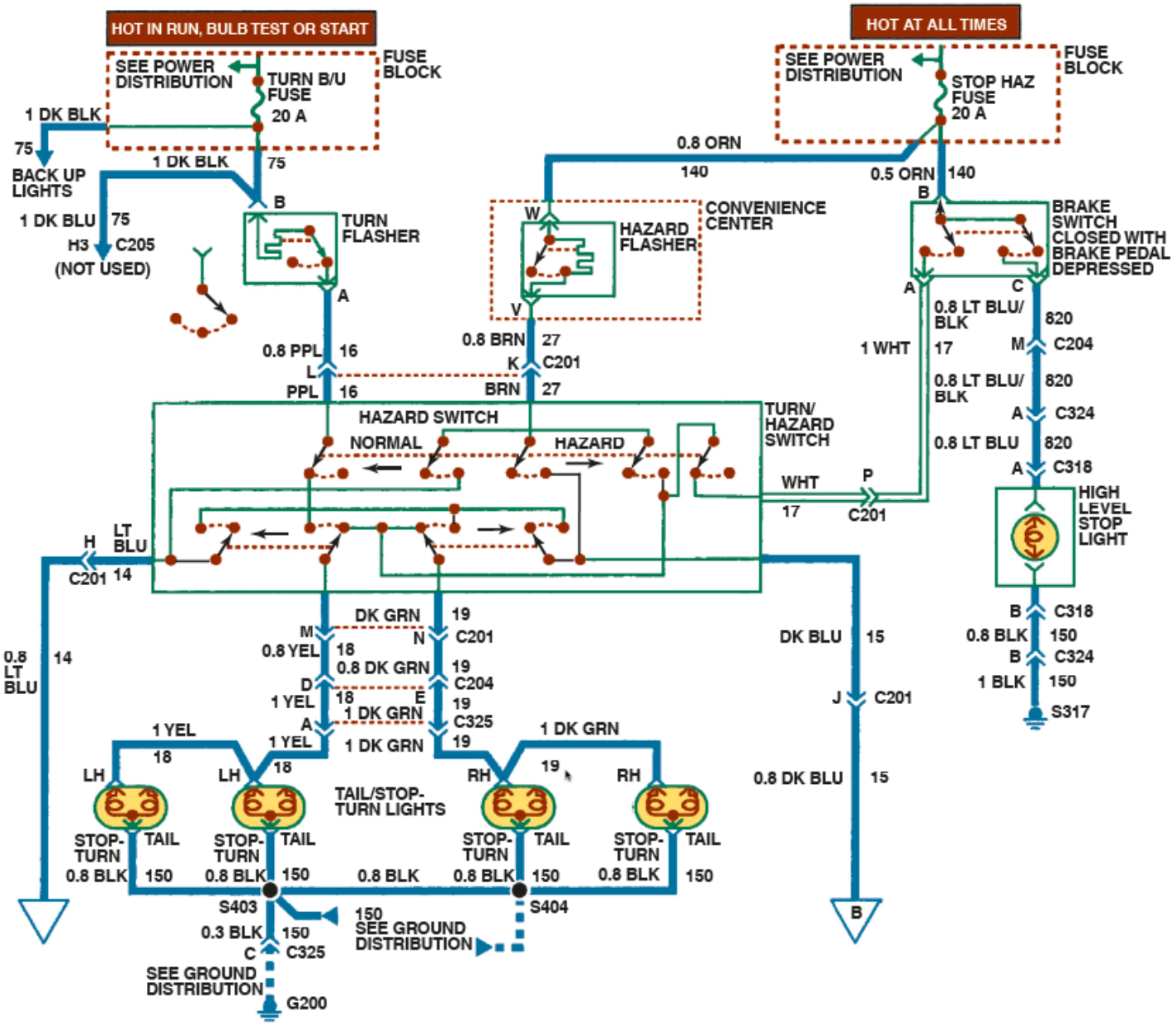

Figure 12. Mechanical turn and hazard flasher system.

Slow turn-signal operation

- Defective flasher unit (if equipped)
- High resistance in sockets or ground wire connections
- Incorrect bulb numbers

Turn signals operating on one side only

- Burned out bulb on the affected side
- Poor ground connection or defective socket on the affected side
- Incorrect bulb number on the affected side
- Defective turn-signal switch

Hazard warning lights inoperative

- Defective hazard flasher unit (if equipped)
- Open in hazard circuit
- Blown fuse
- Defective hazard switch

BCM controlled systems use the turn signal switch or hazard switch as input signals. These systems do not have flasher units. The BCM sends a signal through the data lines to the lighting module(s) to flash the lights. With these systems, the BCM also sends a signal to the radio, which sends a clicking sound to the driver's side speaker, even if the radio is off.

5. Inspect, test, repair and/or replace switches, flasher units, bulbs, sockets, connectors, terminals, wires, and control modules of turn signal and hazard light circuits.

Bulbs can be inspected as covered in ASE task #3, above. On vehicles that use a flasher unit for turn or hazard signals the flasher may be located in the dashboard fuse panel of under the hood. Testing or repair is usually limited to replacement. Figure 13.

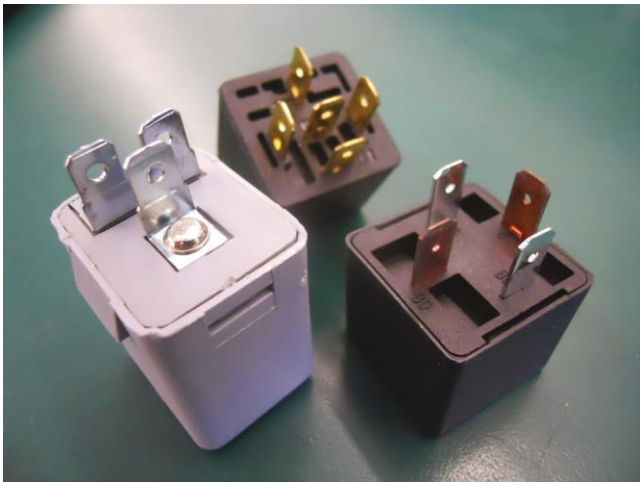

Figure 13. Three types of flasher units.

On many vehicles the turn signal switch is an input to the body control module (BCM). The BCM sends a signal through the data lines to the lighting module(s) to flash the lights. These systems are diagnosed using a scan tool to view data and switch positions. The scan tool can also command the exterior lights on or off for testing.

6. Diagnose the cause of intermittent, dim, continuous or no operation of interior lighting circuits (such as: courtesy, dome, map, vanity, glove box, cargo, trunk, hood, instrument, and accent lighting); determine needed repairs.

Courtesy lights are a generic term primarily used for interior lights, including overhead (dome) and under-the-dash (courtesy) lights. These interior lights are controlled by switches located in the door handle of the vehicle or by a switch on the dash. Most newer vehicles operate the interior lights through the BCM or through an electronic module. Some diagnostic steps are:

Interior light(s) inoperative

- Burned out bulb(s)
- Open in the power-side circuit (blown fuse)
- Open in doorjamb or door handle switch(es)

Interior lights on all the time

- Shorted doorjamb or door handle switch
- Shorted control switch

7. Inspect, test, repair and/or replace switches, relays, bulbs, sockets, connectors, terminals, wires, and control modules of interior lighting circuits (such as: courtesy, dome, map, vanity, glove box, cargo, trunk, hood, instrument, and accent lighting).

Some vehicles are equipped with *illuminated entry*, meaning the interior lights are turned on for a given amount of time when the outside door handle is operated while the doors are locked. Vehicles equipped with body computers use the input from the key fob remote to “wake up” the body computer to turn the lights on.

Instrument panel dimmer controls are used to increase and decrease the brightness of the interior components backlighting. When the body control module (BCM) receives a signal from the I/P dimmer switch it responds by applying a pulse width modulated (PWM) voltage to the various LED instrument panel backlights. To diagnose these systems, connect a factory or enhanced scan tool with bidirectional control of the computer modules to check for proper operation of the affected lighting circuit.

8. Inspect, test, repair and/or replace trailer wiring harness, relays, connectors, and control modules (including brake control).

For trailer connectors, the most common 4 wire plug is a traditional 4-pin flat electrical connector. Color codes are:

1. White = Ground
2. Brown = Taillights, Side Markers and Running Lights
3. Yellow = Left Turn Signal & Left Brake Light

4. Green = Right Turn Signal & Right Brake Light

A 7-Pin Connector (with blades) is very common for larger trailers. Figure 14.

1-4 Wire the first 4 pins just like above.

5. Blue = Electric Brakes.

6. Red (or Black) = 12V Auxiliary Power.

7. Purple (or Gray) = Backup Lights.

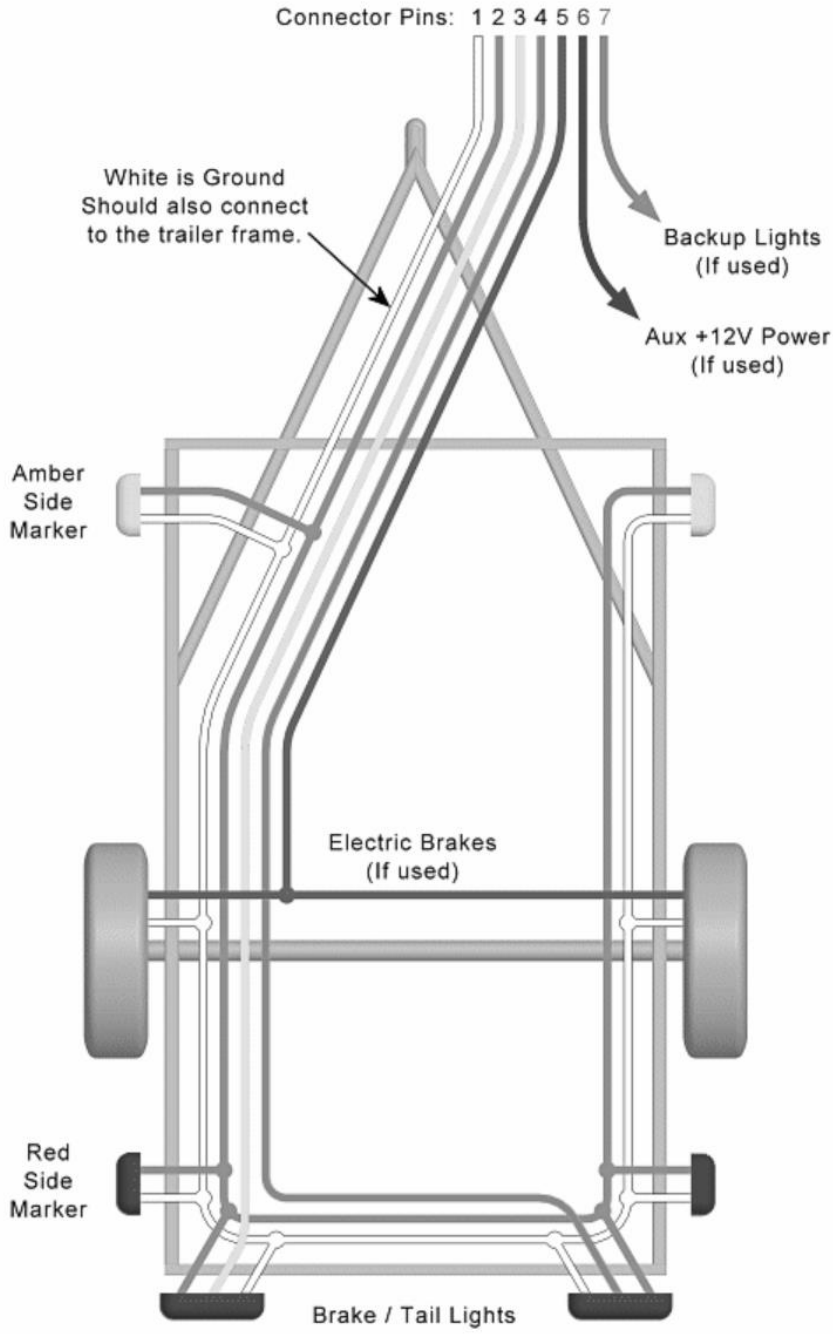

Figure 14. Trailer seven pin connector wiring.