












# A6 Electricity & Electronics 4<sup>th</sup> Edition

## Chapter 23 Lighting & Signaling Circuits

### Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of <b>Automotive Electricity and Electronics Systems</b> . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. <ol style="list-style-type: none"><li>1. Describe how an exterior lighting systems works.</li><li>2. Read and interpret a bulb chart.</li><li>3. Discuss the operation of brake lights and turn signals.</li><li>4. Inspect, replace, and aim headlights and bulbs.</li><li>5. Discuss troubleshooting procedures for lighting and signaling circuits.</li></ol> <p><b>This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic System Diagnosis).</b></p>
Establish the Mood or Climate	Provide a <i>WELCOME</i> , Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

ICONS	Ch23 Lighting & Signaling Circuits
    	<p><b>1. SLIDE 1 CH23 Lighting &amp; Signaling Circuits</b></p> <p><b>2. SLIDES 2-3 EXPLAIN OBJECTIVES</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b>  @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a>  <b>WEB SITE IS CONSTANTLY UPDATED</b></p> <p><b><u>Hazard Lights</u></b>  <b><u>Headlight Circuit</u></b>  <b><u>Headlight Circuit, Parking Lights</u></b>  <b><u>Headlight Circuit, High Beam</u></b>  <b><u>Headlight Circuit, Low Beam</u></b></p> <p><b>4. SLIDE 4 EXPLAIN Exterior Lighting</b></p> <p><b>5. SLIDE 5 EXPLAIN Bulb Numbers</b></p> <p><b>6. SLIDE 6 EXPLAIN Figure 23-1</b> Dual-filament (double-contact) bulbs contain both low-intensity filament for taillights or parking lights and a high-intensity filament for brake lights &amp; turn signals. Bulbs come in a variety of shapes and sizes. Numbers shown are trade numbers.</p> <p><b>7. SLIDE 7 EXPLAIN Figure 23-2</b> Bulbs that have the same trade number have the same operating voltage and wattage. The NA means that the bulb uses a natural amber glass ampoule with clear turn signal lenses.</p>
   <p>QUESTION</p>   <p>QUESTION</p> 	<p><b><u>DEMONSTRATION: PASS A DUAL-FILAMENT BULB AROUND CLASSROOM AND POINT OUT DOUBLE CONTACTS ON THE BOTTOM AND THE METAL CASE USED FOR GROUND</u></b></p> <p><b><u>DISCUSSION: DISCUSS HOW A DUAL FILAMENT BULB WORKS. WHAT ARE ADVANTAGES OF A DUAL FILAMENT BULB VERSUS SINGLE FILAMENT BULB?</u></b></p> <p><b><u>DISCUSSION: DISCUSS BENEFITS OF USING LEDS IN PLACE OF CONVENTIONAL LAMPS. WHAT ARE ENVIRONMENTAL IMPACTS &amp; BENEFITS?</u></b></p> <p><b>8. SLIDE 8 EXPLAIN Figure 23-3</b> Close-up a 2057 dual-filament (double-contact) bulb that failed. Notice that the top filament broke from its mounting and melted onto the lower filament. This bulb caused the dash lights to come on whenever the brakes were applied.</p>

**ICONS****Ch23 Lighting & Signaling Circuits****DEMO**

**DEMONSTRATION: SHOW EXAMPLES OF 3157, 3157NA, AND 3157A BULBS, OR SIMILAR BULBS, TO HELP THEM DISTINGUISH DIFFERENCE BETWEEN BULB SUFFIXES**

9. **SLIDE 9 EXPLAIN Figure 23-4** Corrosion caused the two terminals of this dual-filament bulb to be electrically connected & **EXPLAIN Figure 23-5** Often the best diagnosis is a thorough visual inspection. This bulb was found to be filled with water, which caused weird problems.
10. **SLIDE 10 EXPLAIN Figure 23-6** Single-filament bulb is being tested with DMM set to read resistance in ohms. 1.1 ohms is resistance of bulb when cold. As soon as current flows through filament, resistance increases about 10 times. It is initial surge of current flowing through filament when bulb is cool that causes many bulbs to fail in cold weather as a result of reduced resistance. As temperature increases, resistance increases.

**DEMO****QUESTION**

**DEMONSTRATION: SHOW THE STUDENTS HOW TO TEST THE RESISTANCE OF BULB USING A DMM.**

**DISCUSSION: HAVE STUDENTS TALK ABOUT IMPORTANCE OF SELECTING CORRECT BULB FOR A LAB VEHICLE. HOW IS THE AMOUNT OF LIGHT PRODUCED BY A BULB DETERMINED?**

**DEMO**

**DEMONSTRATION: BUILD A LIGHT BULB CIRCUIT ON TRAINER MEASURE RESISTANCE OF EACH BULB WITH A DMM & USING OHM'S LAW AND CALCULATE THE RESISTANCE OF SEVERAL DIFFERENT LAMPS WITH A GIVEN SOURCE VOLTAGE OF 9 AND 12 VOLTS.**



**HANDS-ON TASK: THEN HAVE STUDENTS BUILD AND MEASURE THE SAME CIRCUIT FROM THE DEMO ON TRAINER**



11. **SLIDE 11 EXPLAIN Figure 23-7** brake light and taillight circuit showing brake switch and all of related circuit components.
12. **SLIDE 12 EXPLAIN FIGURE 23-8** A replacement LED taillight bulb is constructed of many small, individual light-emitting diodes



QUESTION











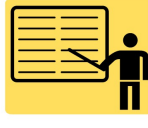

**Hazard Lights**

- 13. SLIDE 13 **EXPLAIN** Turn Signals
- 14. SLIDE 14 **EXPLAIN** Figure 23-9 The typical turn signal switch includes various springs and cams to control the switch and to cause the switch to cancel after a turn has been completed.
- 15. SLIDE 15 **EXPLAIN** Figure 23-10 When the stop lamps and turn signals share a common bulb filament, stop light current flows through the turn signal switch.
- 16. SLIDE 16 **EXPLAIN** Figure 23-11 When a right turn in signaled, the turn signal switch contacts send flasher current to the right-hand filament and brake switch current to the left-hand filament.
- 17. SLIDE 17 **EXPLAIN** Figure 23-12 Two styles of two-prong flasher units.
- 18. SLIDE 18 **EXPLAIN** Turn Signals
- 19. SLIDE 19 **EXPLAIN** Figure 23-13 A hazard warning flasher uses a parallel resistor across the contacts to provide a constant flashing rate regardless of the number of bulbs used in the circuit.

**DEMONSTRATION: SHOW STUDENTS WHAT A SINGLE ELEMENT STOP LAMP/TURN SIGNAL LOOKS LIKE IN OPERATION ON VEHICLE. DO SAME WITH A VEHICLE THAT HAS DUAL ELEMENT BULBS IN STOP LAMP/TURN SIGNAL CIRCUIT.**

**DISCUSSION: DISCUSS OPERATION OF STOP LAMP/TURN SIGNAL CIRCUIT WITH A SINGLE FILAMENT BULB. HOW MANY WIRES ARE FOUND AT TERMINAL CONNECTOR? DISCUSS OPERATION OF A STOP LAMP/TURN SIGNAL CIRCUIT WITH A DUAL FILAMENT BULB.**

- 20. SLIDE 20 **EXPLAIN** Figure 23-14 side-marker light goes out whenever there is voltage at both points X and Y. These opposing voltages stop current flow through the side-marker light. The left turn light and left park light are actually the same bulb (usually 2057) and are shown separately to help explain how the side-marker light works on many vehicles

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	<p><b>DISCUSSION: DISCUSS FUNCTION OF <u>TURN SIGNAL FLASHER</u>. HOW DOES EACH DIFFERENT TYPE OF FLASHER ACCOMPLISH THIS TASK? DISCUSS HOW TO LOCATE TURN SIGNAL FLASHER. USE COMPONENT LOCATION VIEW IN ON-LINE SERVICE INFORMATION TO FIND FLASHER</b></p>
	<p><b>DEMONSTRATION: DISPLAY A SCHEMATIC OF A TYPICAL TURN SIGNAL CIRCUIT &amp; SHOW STUDENTS WHICH SWITCHES ARE GANGED TOGETHER. SHOW HOW GANGED SWITCHES CHANGE STATE AT SAME TIME.</b></p>
	<p><b>DEMONSTRATION: USING TRAINER ; SIMULATE A TURN SIGNAL BULB CIRCUIT &amp; MEASURE ITS RESISTANCE AND AMPERAGE USING A DMM</b></p>
	<p><b>HANDS-ON TASK: HAVE STUDENTS BUILD TURN SIGNAL CIRCUIT ON TRAINER, AS SHOWN IN PREVIOUS DEMO &amp; MEASURE ITS RESISTANCE AND AMPERAGE USING A DMM.</b></p>
	<p><b>Headlight Circuit</b></p>
	<p><b>Headlight Circuit, Parking Lights</b></p>
	<p><b>Headlight Circuit, High Beam</b></p>
	<p><b>Headlight Circuit, Low Beam</b></p>
	<ol style="list-style-type: none"> <li>21. SLIDE 21 <b>EXPLAIN</b> Headlights</li> <li>22. SLIDE 22 <b>EXPLAIN</b> Figure 23-15 Typical headlight circuit diagram. Note that the headlight switch is represented by a dotted outline indicating that other circuits (such as dash lights) also operate from switch.</li> <li>23. SLIDE 23 <b>EXPLAIN</b> Figure 23-16 A typical four-headlight system using sealed beam headlights &amp; <b>EXPLAIN</b> Figure 23-17 typical composite headlamp assembly. The lens, housing, and bulb sockets are usually included as a complete assembly.</li> <li>24. SLIDE 24 <b>EXPLAIN</b> FIGURE 23-18 Handle a halogen bulb by the base to prevent the skin's oil from getting on the glass.</li> </ol>
	<p><b>DISCUSSION: STUDENTS DISCUSS HALOGEN BULBS. WHY SHOULD YOU NEVER TOUCH A HALOGEN BULB WITH YOUR FINGERS?</b></p>

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25. SLIDE 25 **EXPLAIN** HIGH-INTENSITY DISCHARGE HEADLIGHTS

26. SLIDE 26 **EXPLAIN** Figure 23-19 igniter contains ballast & transformer needed to provide high-voltage pulses to arc tube bulb & **EXPLAIN** Figure 23-20 HID (xenon) headlights emit a whiter light than halogen headlights & usually look blue compared to halogen bulbs



**DISCUSSION: DISCUSS OPERATION & OPERATIONAL STATES OF HID (HIGH-INTENSITY DISCHARGE HEADLIGHTS). WHAT COMPONENTS MAKE UP THE SYSTEM? WHAT COSTS ARE ASSOCIATED WITH HID LIGHTS? WHAT IS A BALLAST RESISTOR?**

**HID HEADLIGHTS ARE ALSO KNOWN AS XENON LIGHTS.**



**DISCUSSION: HAVE STUDENTS TALK ABOUT OPERATION OF A TRANSFORMER. WHY IS TRANSFORMER NEEDED IN HID HEADLIGHT SYSTEM?**

**ON-VEHICLE NATEF TASK: IDENTIFY SYSTEM VOLTAGE AND OTHER PRECAUTIONS ASSOCIATED WITH HID HEADLIGHTS.**



27. SLIDE 27 **EXPLAIN** LIGHTING



28. SLIDE 28 **EXPLAIN** Figure 23-21 LED headlights usually require multiple units to provide the needed light as seen on this Lexus LS600h.



**DISCUSSION: HAVE THE STUDENTS TALK ABOUT BENEFITS OF LED HEADLIGHTS. HOW LONG DO THEY LAST? WHAT ARE THEIR ENVIRONMENTAL BENEFITS?**

**HANDS-ON TASK: HAVE STUDENTS DOWNLOAD HEADLIGHT CIRCUIT FOR A LAB VEHICLE & HAVE A DISCUSSION ON CIRCUIT**



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29. **SLIDE 29 EXPLAIN** Figure 23-22 Typical headlight aiming diagram as found in service information.

30. **SLIDE 30 EXPLAIN** Figure 23-23 Many composite headlights have a built-in bubble level to make aiming easy and accurate.

### **ON-VEHICLE NATEF TASK: DIAGNOSE LIGHTING CONCERNS; DETERMINE NECESSARY ACTION (INCLUDES AIMING)**

31. **SLIDE 31 EXPLAIN** Figure 23-24 Adaptive front lighting systems rotate the low-beam headlight in the direction of travel.

32. **SLIDE 32 EXPLAIN** Figure 23-25 A typical adaptive front lighting system uses two motors: one for the up and down movement and the other for rotating the low-beam headlight to the left and right & **EXPLAIN** Figure 23-26 Typical dash-mounted switch that allows the driver to disable the front lighting system.






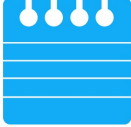



### **DISCUSSION: HAVE STUDENTS DISCUSS OPERATION OF ADAPTIVE FRONT LIGHTING SYSTEMS (AFS). WHICH TYPES OF VEHICLES ARE EQUIPPED WITH AFS? HOW CAN A SCAN TOOL BE USED TO TEST FUNCTION AFS SYSTEMS**

### **HANDS-ON TASK: HAVE STUDENTS DOWNLOAD A WIRING DIAGRAM FOR ADAPTIVE FRONT LIGHTING SYSTEMS (AFS) EQUIPPED VEHICLE. LOCATE COMPONENTS ON A VEHICLE IF POSSIBLE AND TAG THEM.**

### **DEMONSTRATION: PROVIDE SCHEMATIC OF ADAPTIVE FRONT LIGHTING SYSTEMS (AFS). SHOW LOCATION OF EACH COMPONENT IN SYSTEM & WHICH OTHER MODULES AND SENSORS IN VEHICLE ARE USED IN CONJUNCTION WITH**

33. **SLIDE 33 EXPLAIN** LIGHTING

34. **SLIDE 34 EXPLAIN** Figure 23-27 daytime running light (DRL) circuit. Follow arrows from DRL module through both headlights. Notice that left & right headlights are connected in series, resulting in increased resistance, less current flow, & dimmer than normal lighting. When normal headlights are turned on, both headlights receive full battery voltage, with left headlight grounding through the DRL module.

ICONS	Ch23 Lighting & Signaling Circuits
  	<p><b><u>DISCUSSION: OPERATION OF DAYTIME RUNNING LIGHTS (DRL). WHAT ARE SAFETY BENEFITS OF DAYTIME RUNNING LIGHTS?</u></b></p> <p><b>DAYTIME RUNNING LAMPS (DRLS): VEHICLES WITH DRLS MAY NOT HAVE FLASH TO PASS FUNCTION. NEWER VEHICLES MAY USE A LAMP CONTROL MODULE (LCM) TO CONTROL DRLS</b></p> <p>35. SLIDE 35 <b>EXPLAIN</b> Figure 23-28 Most vehicles use positive switching of the high- and low-beam headlights. Notice that both filaments share the same ground connection. Some vehicles use negative switching and place the dimmer switch between filaments and ground.</p>
	<p><b><u>DEMONSTRATION: BUILD RHEOSTAT OR POTENTIOMETER CIRCUIT ON TRAINER. DISCUSS OPERATION OF A RHEOSTAT. SHOW THEM HOW RESISTANCE IN A RHEOSTAT CHANGES AS KNOB IS TURNED. WHAT AUTOMOTIVE APPLICATIONS MIGHT USE RHEOSTATS? WHAT IS DIFFERENCE BETWEEN RHEOSTAT &amp; POTENTIOMETER?</u></b></p>
 	<p><b>DIMMER SWITCH CONNECTED MECHANICALLY TO CONTROL LEVER &amp; COMMON FAILURE ITEM (DEPENDING ON USE) DUE TO MECHANICAL NATURE OF SWITCH</b></p> <p><b>DOME LIGHTS MAY BE CONTROLLED ELECTRONICALLY THROUGH BCM</b></p>
	<p>36. SLIDE 36 <b>EXPLAIN</b> Figure 23-29 A typical courtesy light doorjamb switch. Newer vehicles use the door switch as an input to the vehicle computer and the computer turns the interior lights on or off. By placing the lights under the control of the computer, the vehicle engineers have the opportunity to delay the lights after the door is closed and to shut them off after a period of time to avoid draining the battery.</p>
	<p><b><u>COURTESY LIGHTS</u></b></p>
	<p><b><u>DISCUSSION: TALK ABOUT OPERATION OF PHOTORESISTORS &amp; PHOTODIODES. HOW COULD THESE COMPONENTS BE INCORPORATED INTO AUTOMATIC HEADLIGHT CIRCUITS?</u></b></p>



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**DISCUSSION: DISCUSS HOW COMPUTER IS USED TO CONTROL COURTESY LIGHTS AND ILLUMINATED ENTRY ON SOME VEHICLES. WHAT ARE SYSTEM'S INPUTS AND HOW DOES THE COMPUTER RECEIVE DATA FROM ALL OF THEM?**

37. SLIDE 37 **EXPLAIN** Figure 23-30 An automatic dimming mirror compares the amount of light toward the front of the vehicle to the rear of the vehicle and allies a voltage to cause the gel to darken the mirror

38. SLIDE 38 **EXPLAIN** FEEDBACK

39. SLIDES 39-40 **EXPLAIN** LIGHTING SYSTEM DIAGNOSIS

41. SLIDES 41-42 **EXPLAIN** SUMMARY

**SHOW VIDEO: DIAGNOSING TURN SIGNALS**  
**WWW.MYAUTOMOTIVELAB.COM**

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=DIAGNOSING%20TURN%20SIGNALS&CLIP=PANDC/CHET/2012/AUTOMOTIVE/STARTING\\_CHARGING\\_ELECT/A6T8.MOV&CAPTION=CHET/CHET\\_MYLABS/AKAMAI/2012/AUTOMOTIVE/STARTING\\_CHARGING\\_ELECT/XML/A6T8.XML](http://media.pearsoncmg.com/ph/chet/chet_myLABS/akamai/template/video640x480.php?title=diagnosing%20turn%20signals&clip=pandc/chet/2012/automotive/starting_charging_elect/a6t8.mov&caption=chet/chet_myLABS/akamai/2012/automotive/starting_charging_elect/xml/a6t8.xml)