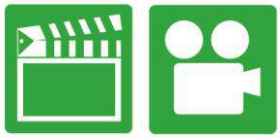
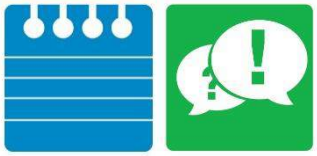
Automotive Electrical & Engine Performance 7/E

Chapter 9 Wiring Schematics & Circuit Testing

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	**This course or class covers Automotive Electrical & Engine Performance. 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. 1. Prepare for ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronics System Diagnosis). 2. Interpret wiring schematics. 3. Explain how relays work. 4. Discuss the various methods that can be used to locate a short circuit. 5. List the electrical troubleshooting diagnosis steps.
Establish the Mood or Climate	Provide a *WELCOME,* 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.

NOTE: This lesson plan is based on Automotive Electrical & Engine Performance 7/E Chapter Images found on Jim's web site @ www.jameshalderman.com
LINK CHP 9: Chapter Images

ICONS	Ch09 Wiring Schematics & Circuit Testing
	**1. SLIDE 1 CH09 WIRING SCHEMATICS & CIRCUIT TESTING**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **Videos**
	
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	
	**DISCUSSION: TALK ABOUT CIRCUIT INFORMATION ON A WIRING DIAGRAM. HOW IS A WIRING DIAGRAM SIMILAR TO A ROADMAP?**
	2. **SLIDE 2 EXPLAIN Figure 9-1** The center wire is a solid color wire, meaning that the wire has no other identifying tracer or stripe color. The two end wires could be labeled "BRN/WHT," indicating a brown wire with a white tracer or stripe. 3. **SLIDE 3 EXPLAIN Figure 9-2** Typical section of a wiring diagram. Notice that 2 wire color changes at connection C210. 2 ".8" represents 2 metric wire size in square **millimeters**. 4. **SLIDE 4 EXPLAIN Figure 9-3** Electrical/electronic symbols used in automotive wiring & circuit diagrams.
	
	**EXPLAIN TECH TIP**
	**DEMONSTRATION: PROCURE A WIRING HARNESS TO SHOW STUDENTS VARIOUS COLORS OF WIRES IN HARNESS**

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	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE VARIOUS COLORS OF THE WIRES IN A WIRING HARNESS. WHAT IS THE SIGNIFICANCE OF DIFFERENT COLORS?**
	**DISCUSSION: HAVE STUDENTS DISCUSS THE SYMBOLS USED TO INDICATE MALE AND FEMALE CONNECTORS. WHY IS BATTERY SIDE OF CONNECTOR FEMALE & NOT MALE? HAVE STUDENTS STUDY CHART 9–3 TO BECOME FAMILIAR WITH SYMBOLS USED IN WIRING DIAGRAMS. WHAT DO SHORTER AND LONGER LINES ON BATTERY SYMBOL MEAN? HOW IS WIRING SHOWN?**
	5. **SLIDE 5 EXPLAIN FIGURE 9-4** In this typical connector, note that the positive terminal is usually a female connector.
	6. **SLIDE 6 EXPLAIN Figure 9-5** symbol for a battery. The positive plate of a battery is represented by the longer line and the negative plate by the shorter line. The voltage of the battery is usually stated next to the symbol
	7. **SLIDE 7 EXPLAIN Figure 9-6** ground symbol on the left represents earth ground. The ground symbol on the right represents a chassis ground.
	8. **SLIDE 8 EXPLAIN Figure 9-7** Starting at top, wire from ignition switch is attached to terminal B of connector C2, wire is 0.5 mm^2 (20 gauge AWG), and yellow. Circuit number is 5. Wire enters connector C202 at terminal B3.
	9. **SLIDE 9 EXPLAIN Figure 9-8** electrical terminals are usually labeled with a letter or number
	10. **SLIDE 10 EXPLAIN Figure 9-9** Two wires that cross at the dot indicate that the two are electrically connected.
	**DEMONSTRATION: PROCURE A WIRING HARNESS WITH SPLICES. OPEN IT UP TO SHOW SPLICES IN HARNESS AND EXPLAIN THE NEED FOR SPLICES.**
	11. **SLIDE 11 EXPLAIN Figure 9-10** Wires that cross, but do not electrically contact each other, are shown with one wire bridging over the other.
	12. **SLIDE 12 EXPLAIN Figure 9-11** Connectors (C), grounds (G), and splices (S) are followed by a number, generally indicating the location in the vehicle. For example, G209 is a ground connection located under dash.

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	**DISCUSSION: TALK ABOUT NUMBERS USED TO INDICATE GENERAL AREAS FOR CONNECTION LOCATIONS. WHY IS THERE NEED TO SEPARATE VEHICLE INTO DIFFERENT AREAS TO SIMPLIFY REPAIRS? WHAT IS DIFFERENCE BETWEEN EVEN & ODD NUMBERED CONNECTORS?**
	13. **SLIDE 13 EXPLAIN Figure 9-12** ground for the battery is labeled G305 indicating the ground connector is located in the passenger compartment of the vehicle. The ground wire is black (BLK), the circuit number is 50, and the wire is 32 mm^2 (2 gauge AWG). 14. **SLIDE 14 EXPLAIN Figure 9-13** The symbol for light bulbs shows the filament inside a circle, which represents the glass ampoule of the bulb 15. **SLIDE 15 EXPLAIN Figure 9-14** An electric motor symbol shows a circle with the letter M in the center and two black sections that represent the brushes of the motor. This symbol is used even though the motor is a brushless design 16. **SLIDE 16 EXPLAIN Figure 9-15** Resistor symbols vary depending on the type of resistor.
	17. **SLIDE 17 EXPLAIN Figure 9-16** rheostat uses only two wires—one is connected to a voltage source and the other is attached to the movable arm 17. **SLIDE 18 EXPLAIN Figure 9-17** Symbols used to represent capacitors. If one of the lines is curved, this indicates that the capacitor being used has a polarity, while the one without a curved line can be installed in the circuit without concern about polarity. 19. **SLIDE 19 EXPLAIN Figure 9-18** grid like symbol represents an electrically heated element. Symbol represents a cigarette lighter or heated rear window 20. **SLIDE 20 EXPLAIN Figure 9-19** Dashed outline represents a portion (part) of a component
	**DISCUSSION: DISCUSS SYMBOLS USED TO REPRESENT CAPACITORS ON WIRING DIAGRAMS. WHY ARE 2 DIFFERENT SYMBOLS NEEDED FOR CAPACITORS?**
	21. **SLIDE 21 EXPLAIN Figure 9-20** Solid box represents an entire component 22. **SLIDE 22 EXPLAIN Figure 9-21** Symbol represents a component that is case grounded.

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	**DEMONSTRATION: SHOW STUDENTS HOW TO USE A COPY OF A WIRING DIAGRAM AND HIGHLIGHTER TO TRACE CIRCUITS FOR TESTING OR REPAIR.**
	**23. SLIDE 23 EXPLAIN Figure 9-22** (a) A symbol for a single-pole, single-throw (SPST) switch. This type of switch is normally open (N.O.) because nothing is connected to the terminal that the switch is contacting in its normal position. (b) A single-pole, double-throw (SPDT) switch has three terminals. (c) A double-pole, single-throw (DPST) switch has two positions (off and on) and can control two separate circuits. (d) A double-pole, double-throw (DPDT) switch has six terminals—three for each pole. Note: Both (c) and (d) also show a dotted line between the two arms indicating that they are mechanically connected, called a "ganged switch." **24. SLIDE 24 EXPLAIN Figure 9-23 (a)** symbol for a normally open (N.O.) momentary switch **(b)** symbol for a normally closed (N.C.) momentary switch.
	**EXPLAIN TECH TIP**
	**25. SLIDE 25 EXPLAIN FIGURE 9-24** Using a marker and color-coding the various parts of the circuit makes the circuit easier to understand and helps diagnosing electrical problems easier.
	**26. SLIDE 26 EXPLAIN Figure 9-25** relay uses a movable arm to complete a circuit whenever there is a power at terminal 86 and a ground at terminal 85. A typical relay only requires about 1/10 ampere through the relay coil. The movable arm then closes the contacts (#30 to #87) and can relay 30 amperes or more. **27. SLIDE 27 EXPLAIN Figure 9-26** cross-sectional view of a typical 4-terminal relay. Current flowing through coil (terminals 86 and 85) causes movable arm (called armature) to be drawn toward coil magnet. Contact points complete electrical circuit connected to terminals 30 & 87. **28. SLIDE 28 EXPLAIN Figure 9-27** typical relay showing the schematic of the wiring in the relay
	**DISCUSSION: HAVE STUDENTS TALK ABOUT OPERATION OF NORMALLY OPEN AND NORMALLY CLOSED RELAYS. WHAT ARE THE APPLICATIONS**

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	FOR NORMALLY OPEN RELAYS? WHAT ARE THE APPLICATIONS FOR NORMALLY CLOSED RELAYS?
	**EXPLAIN TECH TIP**
	29. **SLIDE 29 EXPLAIN FIGURE 9.28** All schematics are shown in their normal, non-energized position 30. **SLIDE 30 EXPLAIN Figure 9-29** typical horn circuit. Note that relay contacts supply the heavy current to operate horn when horn switch simply completes a low-current circuit to ground, causing relay contacts to close. 31. **SLIDE 31 EXPLAIN Figure 9-30** When relay or solenoid coil current is turned off, the stored energy in coil flows through clamping diode and effectively reduces voltage spike. 32. **SLIDE 32 EXPLAIN Figure 9-31** resistor used in parallel with the coil windings is a common spike reduction method used in many relays
	**DISCUSSION: ASK STUDENTS TO TALK ABOUT CONTROLLING RELAY VOLTAGE SPIKES. HOW DOES DIODE USED IN A RELAY COIL CIRCUIT ELIMINATE VOLTAGE SPIKES?**
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**AN INOPERATIVE CIRCUITINVOLVING A RELAY CAN BE DIVIDED IN ½ FOR TESTING. HIGH-CURRENT AND LOW-CURRENT SIDES CAN BE TESTED SEPARATELY TO DETERMINE WHICH SIDE OF CIRCUIT IS INOPERATIVE.**
	**LAB HANDS-ON TASK: STUDENTS COMPLETE WORKSHEET ON HIGHLIGHTING WIRING DIAGRAMS**
	33. **SLIDE 33 EXPLAIN Figure 9-32** typical wiring diagram showing multiple switches & bulbs powered by one fuse.
	**DISCUSS REAL WORLD FIX**

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	**EXPLAIN TECH TIP**
	**STUDENTS COMPLETE NATEF TASK SHEET: USE WIRING DIAGRAMS DURING DIAGNOSIS OF ELECTRICAL CIRCUIT PROBLEMS**
	**DEMONSTRATION: USE TRAINER FOR AN OPEN CIRCUIT. HAVE STUDENTS WORK THROUGH CIRCUIT TROUBLESHOOTING PROCEDURE WITH YOU. EXPLAIN REASON FOR TESTING SIMPLE THINGS FIRST. TRY OUT THIS EXERCISE BEFORE CLASS TO MAKE SURE IT WORKS PROPERLY FOR DEMONSTRATING TO STUDENTS.**
	**34. SLIDE 34 EXPLAIN Figure 9-33** To add additional lighting, simply tap into an existing light wire & connect a relay. Whenever the existing light is turned on, the coil of the relay is energized. The arm of the relay then connects power from another circuit (fuse) to auxiliary lights without overloading the existing light circuit.
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**35. SLIDE 35 EXPLAIN Figure 9-34** Always check simple things first. Check fuse for circuit you are testing. Maybe a fault in another circuit controlled by same fuse could have caused fuse to blow. Use a test light to check that both sides of fuse have voltage
	**DISCUSSION: DISCUSS CIRCUIT BREAKER METHOD OF TESTING FOR A SHORT-TO-GROUND CIRCUIT. WHY IS THIS A BETTER ALTERNATIVE THAN FUSE REPLACEMENT METHOD?**
	**36. SLIDE 36 EXPLAIN: Figure 9-35 (a)** After removing the blown fuse, a pulsing circuit breaker is connected to the terminals of fuse. **37. SLIDE 37 EXPLAIN: Figure 9-35 (b)** circuit breaker causes current to flow, then stop, then flow again, through circuit up to point of the short-to-ground. By observing the Gauss gauge, location of short is indicated near where the needle stops moving due to the magnetic field created by the flow of current through the wire.

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	38. **SLIDE 38 EXPLAIN Figure 9-36** Gauss gauge can be used to determine the location of a short circuit even behind a metal panel. 39. **SLIDE 39 EXPLAIN Figure 9-37** tone generator-type tester used to locate open circuits and circuits that are shorted-to-ground. Included with this tester is a transmitter (tone generator), receiver probe, and headphones for use in noisy shops. 40. **SLIDE 40 EXPLAIN Figure 9-38** To check for a short-to-ground using a tone generator, connect black transmitter lead to a good chassis ground & red lead to load side of fuse terminal. Turn the transmitter on and check for tone signal with the receiver. Using a wiring diagram, follow strongest signal to short-to-ground. There will be no signal beyond the fault, either a short-to-ground as shown or an open circuit
	**EXPLAIN TECH TIP**
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**DEMONSTRATION: SHOW STUDENTS HOW A GAUSS GAUGE WORKS. HAVE THEM USE GAUSS GAUGE TO CHECK FOR A SHORTED WIRE.**
	**DISCUSSION: HAVE STUDENTS DISCUSS FOUR METHODS OF TESTING FOR A SHORT-TO-GROUND CIRCUIT. WHICH METHOD WOULD BE EASIEST, & WHICH WOULD BE MOST DIFFICULT? WHY?**
	**DEMONSTRATION: RAISE A VEHICLE ON A LIFT. HAVE STUDENTS INSPECT & LOCATE AREAS WHERE POTENTIAL ELECTRICAL OR ELECTRONIC PROBLEMS COULD OCCUR FROM HEAT OR MOVEMENT OF A WIRING HARNESS.**
	41. **SLIDE 41 EXPLAIN Figure 39** Antistatic spray can be used by customers to prevent being shocked when they touch a metal object like the door handle
	**DISCUSS REAL WORLD FIX**

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 	**NATEF TASK SHEET:** LOCATE SHORTS, GROUNDS, OPENS, & RESISTANCE PROBLEMS IN ELECTRICAL/ELECTRONIC CIRCUITS; DETERMINE NECESSARY ACTION. **NATEF TASK SHEET:** IDENTIFY AND INTERPRET ELECTRICAL/ELECTRONIC SYSTEM CONCERN; DETERMINE NECESSARY ACTION