

Automotive Heating And Air Conditioning

Eighth Edition

Automotive Heating and Air Conditioning

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Chapter 10

HVAC Electricity and Electronics

ALWAYS LEARNING

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Learning Objectives

10.1 Prepare for the Heating and Air Conditioning (A7) ASE certification test content area "D" (Operating Systems and Related Controls Diagnosis and Repair).

10.2 Explain the characteristics of electricity.

10.3 Differentiate between conductors, insulators, and semiconductors.

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Learning Objectives

10.4 Explain the units of electrical measurement.

10.5 List the parts of a complete circuit.

10.6 Discuss the types of electrical circuit faults.

10.7 Explain how to detect and measure electrical voltage, current, and resistance using digital meters.

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Learning Objectives

10.8 Discuss wire repair.

10.9 Discuss the purpose of terminals, connectors, relays, and switches.

10.10 Discuss networks and network classifications.

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Introduction

• Electricity may be difficult for some people to learn for the following reasons:

- It cannot be seen.
- Only the results of electricity can be seen.
- It has to be detected and measured

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Electricity (1 of 2)

• Electricity is the movement of electrons from one atom to another.

- Nucleus
 - Protons, neutrons, and electrons

• Automotive electricity uses the conventional theory that electricity flows from positive to negative.

• Magnets and electrical charge

• Electron orbits

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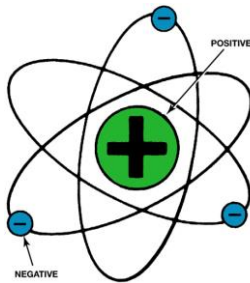
Electricity (2 of 2)

- **Conductors**
 - Conductors are materials with fewer than four electrons in their atom's outer orbit.
- **Insulators**
 - Insulators are materials with more than four electrons in their atom's outer orbit.
- **Semiconductors**
 - Materials with exactly four electrons in their outer orbit are called semiconductors.

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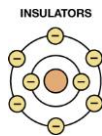
FIGURE 10-2 The nucleus of an atom has a positive (+) charge and the surrounding electrons have a negative (–) charge.



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FIGURE 10-7 Insulators are elements with five to eight electrons in the outer orbit.



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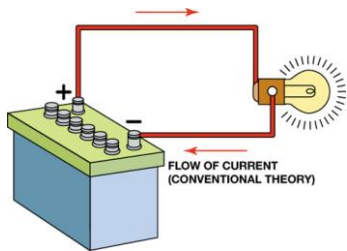
How Electrons Move Through a Conductor

- Current flow
- Conventional Theory versus Electron Theory
 - What is the difference?

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FIGURE 10-10 Conventional theory states that current flows through a circuit from positive (+) to negative (-). Automotive electricity uses the conventional theory in all electrical diagrams and schematics.



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Units of Electricity

- The three fundamentals of electricity-related units include the ampere, volt, and ohm
 - The ampere is the measure of the amount of current flow.
 - Voltage is the unit of electrical pressure.
 - The ohm is the unit of electrical resistance.

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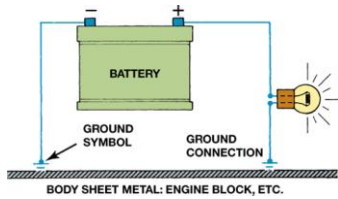
Electrical Circuits

- All complete electrical circuits have:
 - A power source, a circuit protection device, a power-side wire or path, an electrical load, a ground return path, and a switch or a control device.
- Circuit testers include test lights and fused jumper leads.

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FIGURE 10–16 The return path back to the battery can be any electrical conductor, such as a copper wire or the metal frame or body of the vehicle.



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Electrical Schematics (1 of 2)

- All circuit schematics or diagrams include:
 - Power-side wiring of the circuit
 - All splices
 - Connectors
 - Wire size
 - Wire color
 - Trace color (if any)
 - Circuit number
 - Electrical components

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Electrical Schematics (2 of 2)

- Ground return paths
- Fuses and switches
- Circuit information
- Wire size
- Open circuits
- Short-to-voltage
- Short-to-ground
- High resistance

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FIGURE 10-18 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 “BLU/WHIT,” indicating a blue wire with a white tracer or stripe.



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Types of Circuit Faults (1 of 2)

- An open circuit is any circuit that is not complete, or that lacks continuity, such as a broken wire.
- A short-to-voltage occurs when the power side of one circuit is electrically connected to the power side of another circuit.

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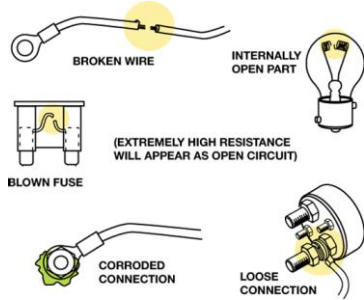
Types of Circuit Faults (2 of 2)

- A short-to-ground is a type of short circuit that occurs when the current bypasses part of the normal circuit and flows directly to ground.
- High resistance is resistance higher than normal circuit resistance.

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FIGURE 10–21 Examples of common causes of open circuits. Some of these causes are often difficult to find.



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Fused Jumper Wire

- Purpose and function
 - Fuse
 - Alligator clip ends
 - Good-quality insulated wire

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FIGURE 10–25 A technician-made fused jumper lead, which is equipped with a red 10-ampere fuse. This fused jumper wire uses terminals for testing circuits at a connector instead of alligator clips.



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Test Light

- Non-powered test light
- Use of a 12-volt test light
 - Electrical power
 - Grounds

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FIGURE 10–26 Testing a fuse with a test light. If the fuse is good, the test light should light on both sides (power side and load side) of the fuse.



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Digital Meters

- A voltmeter measures the pressure or potential of electricity in units of volts
- An ohmmeter measures the resistance in ohms of a component or circuit section when no current is flowing through the circuit
- An ammeter measures the flow of current through a complete circuit in units of amperes or milliamperes

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FIGURE 10-31 Using a digital multimeter set to read ohms (Ω) to test this light bulb. The meter reads the resistance of the filament.



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Inductive Ammeters

- What is the operation of inductive ammeters?
- AC/DC clamp-on digital multimeters
- Think of money
 - The display for a battery measured as 12 1/2 volts would be 12.50 V, just as \$12.50 is 12 dollars and 50 cents.

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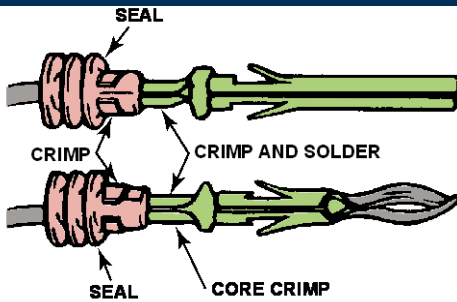
Terminals and Connectors

- A terminal is the metal end of a wire, whereas a connector is the plastic housing for the terminal.
- Servicing terminals

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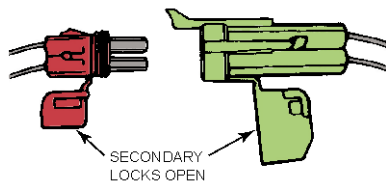
Figure 10-37 Some terminals have seals attached to help seal the electrical connections



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FIGURE 10-39 The secondary locks help retain the terminals in the connector.



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Wire Repair (1 of 2)

- Many manufacturers recommend that all wiring repairs be soldered.
 - Solder is an alloy of tin and lead used to make a good electrical contact between two wires or connections in an electrical circuit.
- Terminals can be crimped to create a good electrical connection if the proper type of crimping tool is used.

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Wire Repair (2 of 2)

- Heat shrink tubing is usually made from polyvinyl chloride (PVC) or polyolefin and shrinks to about half of its original diameter when heated; this is usually called a 2:1 shrink ratio.
 - Heat shrink by itself does not provide protection against corrosion.

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Relays

- A relay is a magnetic switch that uses a movable armature to control a high-amperage circuit by using a low-amperage electrical switch.
- Terminal identification
 - Coil
 - Other terminals used to control the load current

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Network Classifications

- The SAE communication classifications for vehicle communications system.
 - Class A
 - Class B
 - Class C

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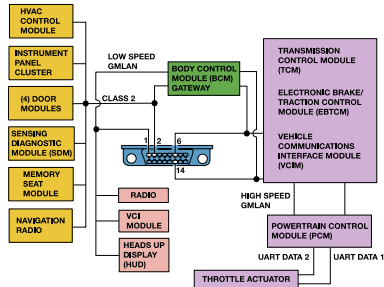
Controller Area Network

- Robert Bosch Corporation developed the CAN protocol, which was called CAN 1.2, in 1993.
- What is the CAN?

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FIGURE 10–55 A schematic of a Chevrolet Equinox shows that the vehicle uses a GMLAN BUS (DLC pins 6 and 14), plus a Class 2 (pin 2). A scan tool can therefore communicate to the transmission control module (TCM) through the high-speed network. Pin 1 connects to the low-speed GMLAN network.



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Summary (1 of 3)

- Electricity is the movement of electrons from one atom to another.
- Automotive electricity uses the conventional theory that electricity flows from positive to negative.
- The ampere is the measure of the amount of current flow.
- Voltage is the unit of electrical pressure.

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Summary (2 of 3)

- The ohm is the unit of electrical resistance.
- All complete electrical circuits have a power source, a circuit protection device, a power-side wire or path, an electrical load, a ground return path, and a switch or a control device.
- Circuit testers include test lights and fused jumper leads.

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Summary (3 of 3)

- A terminal is the metal end of a wire, whereas a connector is the plastic housing for the terminal.
- The use of a network for module communications reduces the number of wires and connections needed.
- The SAE communication classifications for vehicle communications system.

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