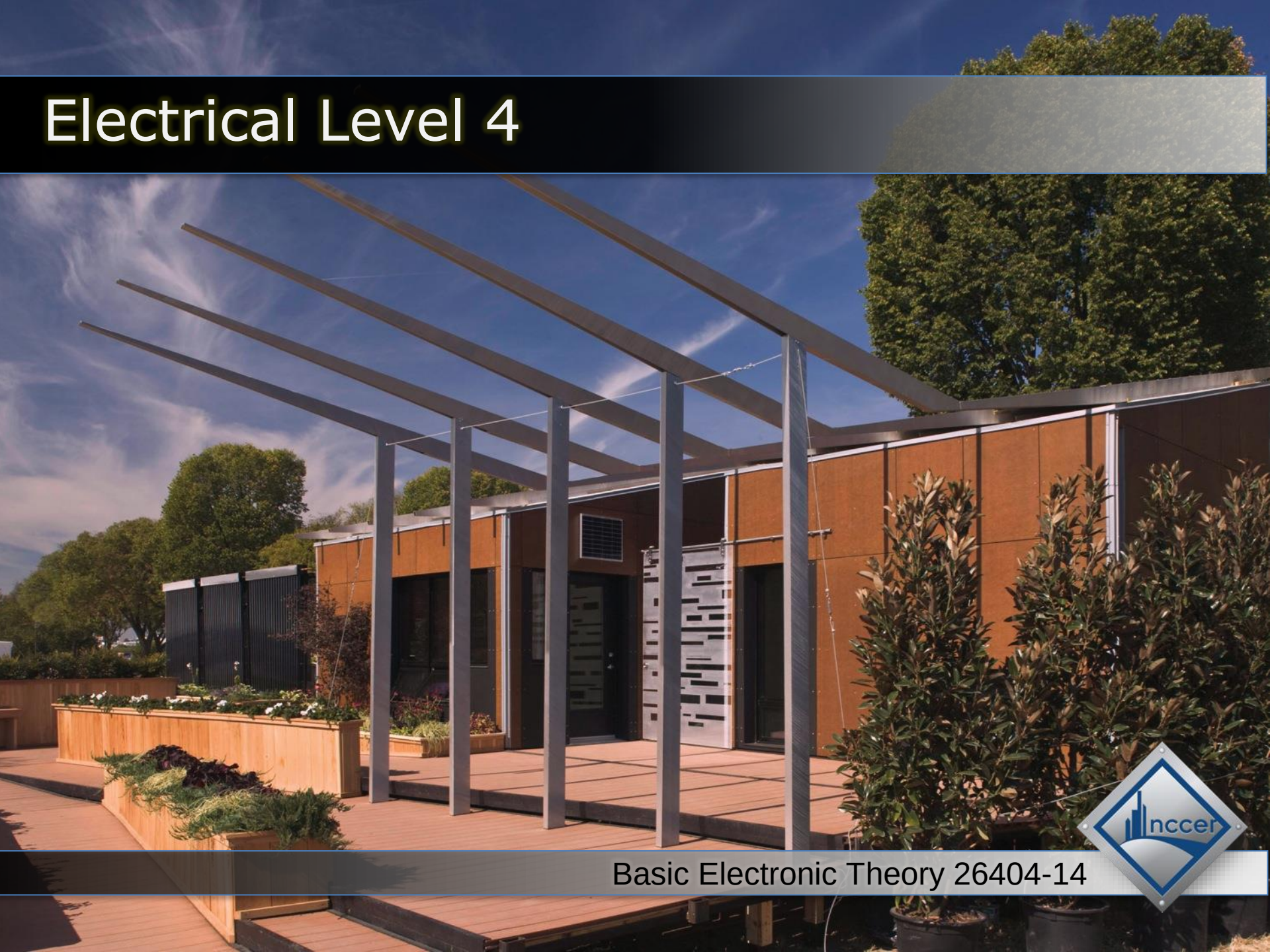
Electrical Level 4



Basic Electronic Theory 26404-14

Objectives

When trainees have completed this lesson, they should be able to do the following:

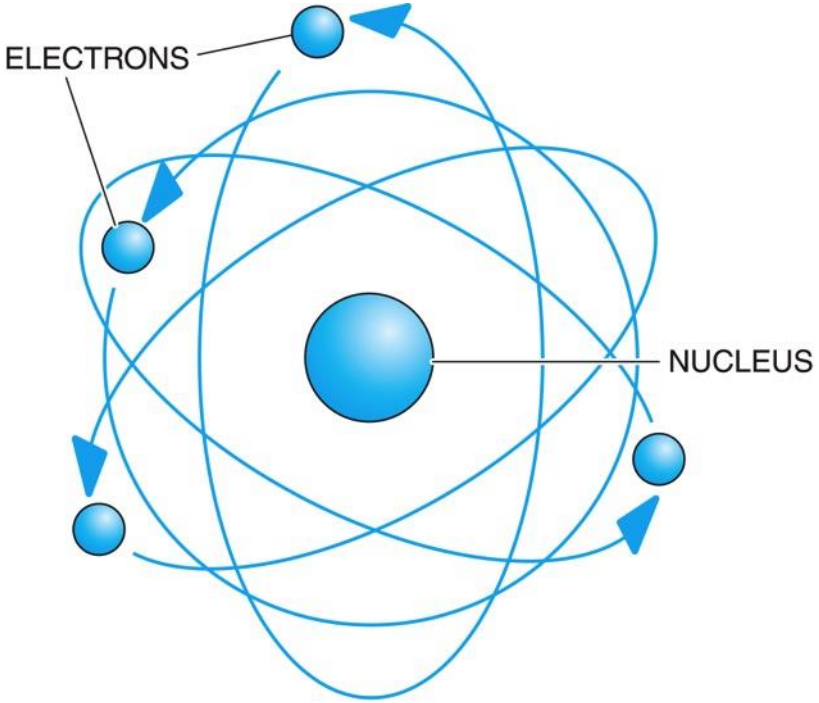
1. Identify electronic system components.
2. Describe the electrical characteristics of solid-state devices.
3. Describe the basic materials that make up solid-state devices.
4. Describe and identify the various types of transistors and explain how they operate.
5. Interpret electronic schematic diagrams.
6. Describe and connect diodes.
7. Describe and connect light-emitting diodes (LEDs).
8. Describe how to connect silicon-controlled rectifiers (SCRs).
9. Identify the leads of various solid-state devices.

Performance Tasks

1. Test a transistor to determine whether it is an NPN or PNP.
2. Identify the cathode on three different styles of SCRs, using the shape or markings for identification.

Introduction; Electricity Under Magnification

- Electronic circuits use voltages of 24V and lower, and amperages measured in milliamps or microamps.
- Electronics deals with the behavior and effect of electron flow on an atomic level. A basic atom contains a nucleus orbited by electrons.



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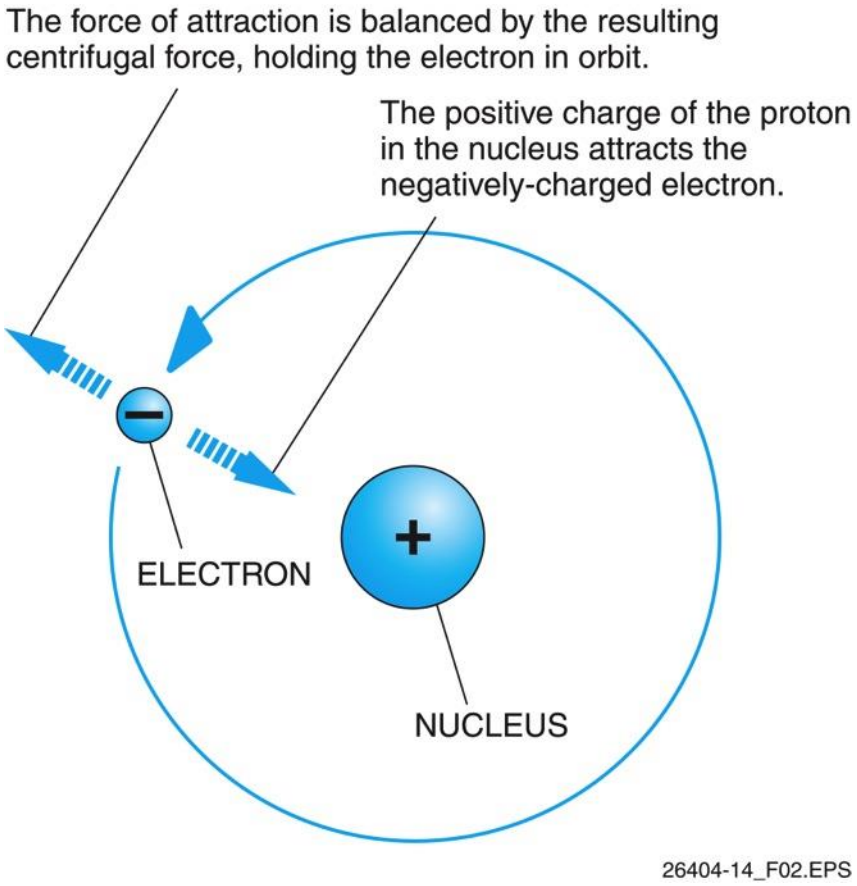
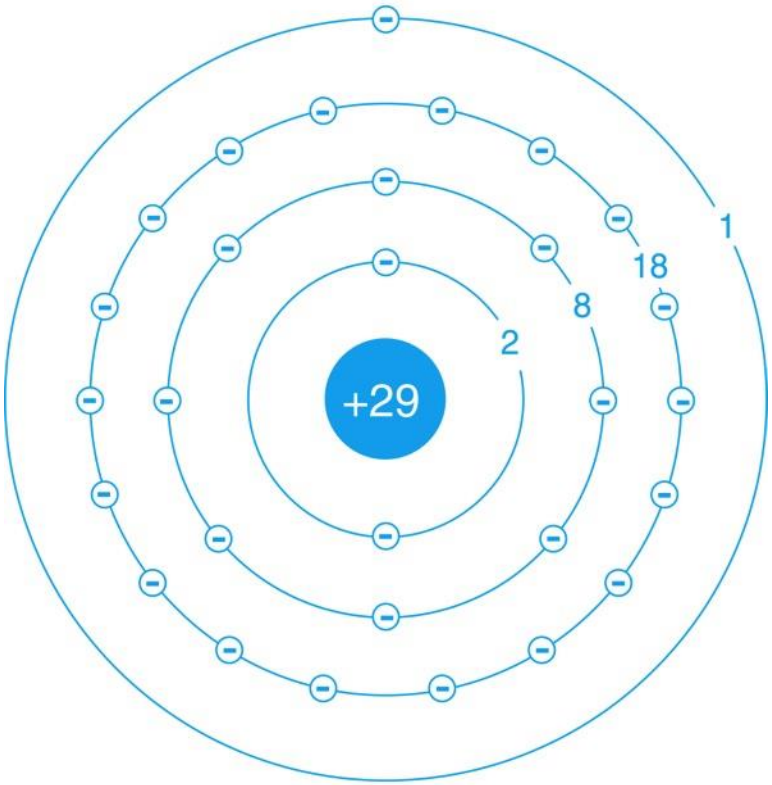
Electron in Orbit around the Nucleus

- Since the protons and electrons are equal in number, they are electrically neutral.
- If an atom gains an electron, it becomes a negative ion. If an atom loses an electron, it becomes a positive ion.
- The electron flow between two oppositely charged atoms is electricity.



Semiconductor Fundamentals

- Conductors have only one or two electrons in their outer shell that are held loosely in orbit and easily released to create current flow.
- Gold, silver, and copper are all good conductors. Copper is the most widely used.



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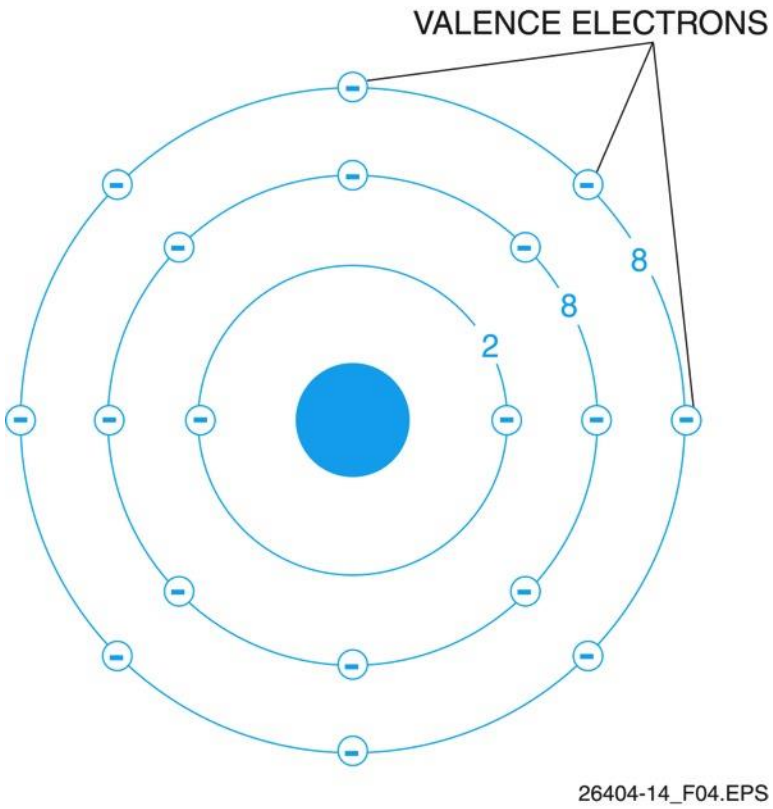
Atom of an Insulator

- Insulators have more than four electrons in their outer shell that are held tightly in orbit and not easily released.
- Rubber, glass, and plastic are common types of insulators.

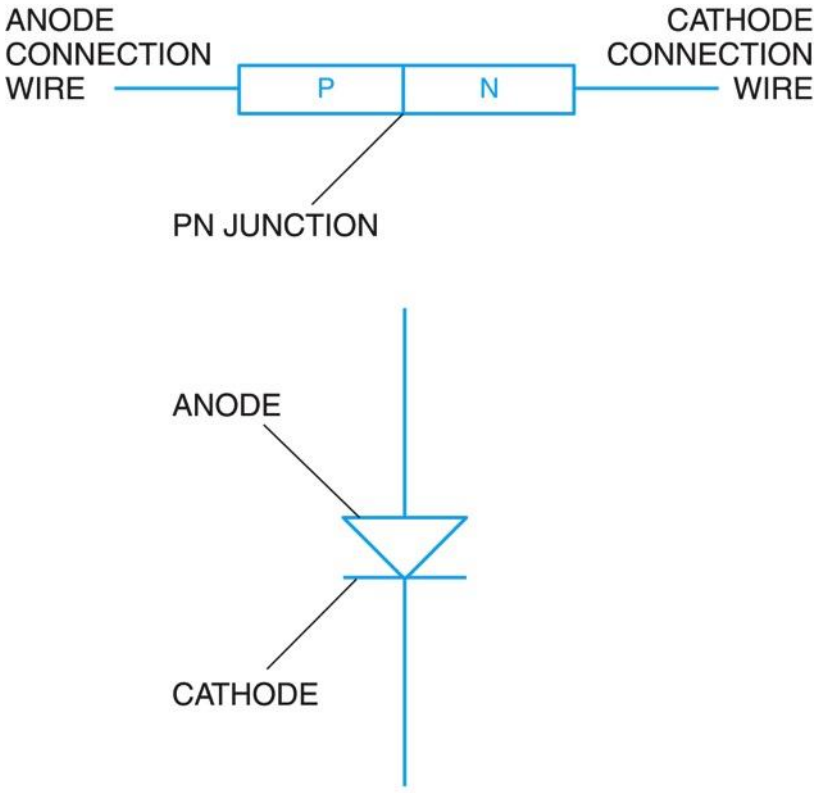


Next Session…

Diodes

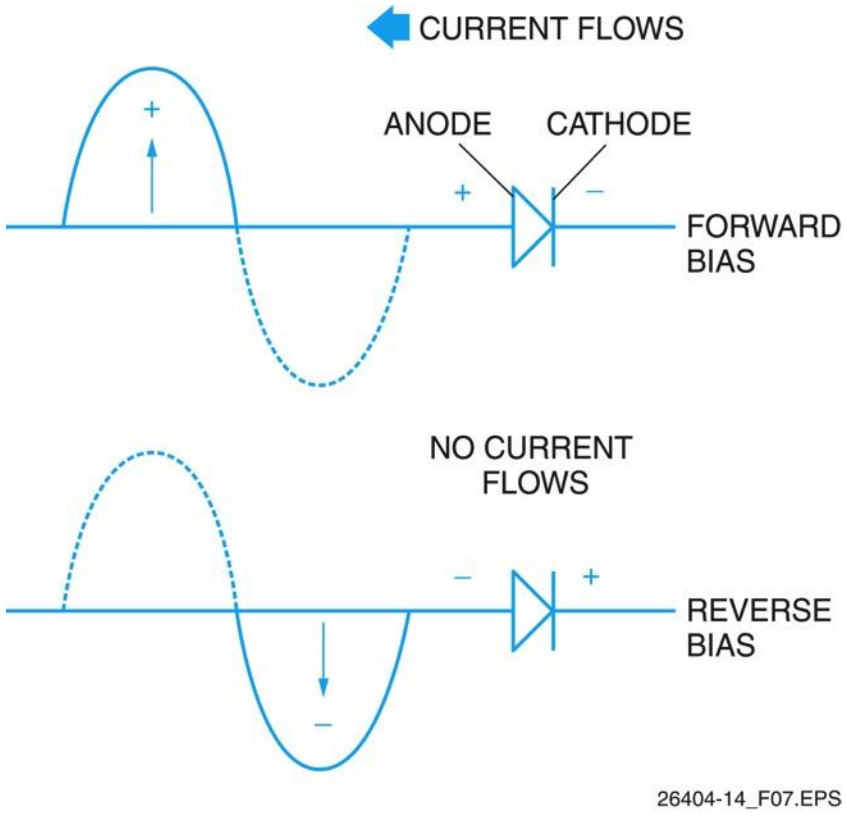
Diodes

- A diode is created by joining a piece of P-type material with a piece of N-type material.
- Diodes allow current flow in one direction only.



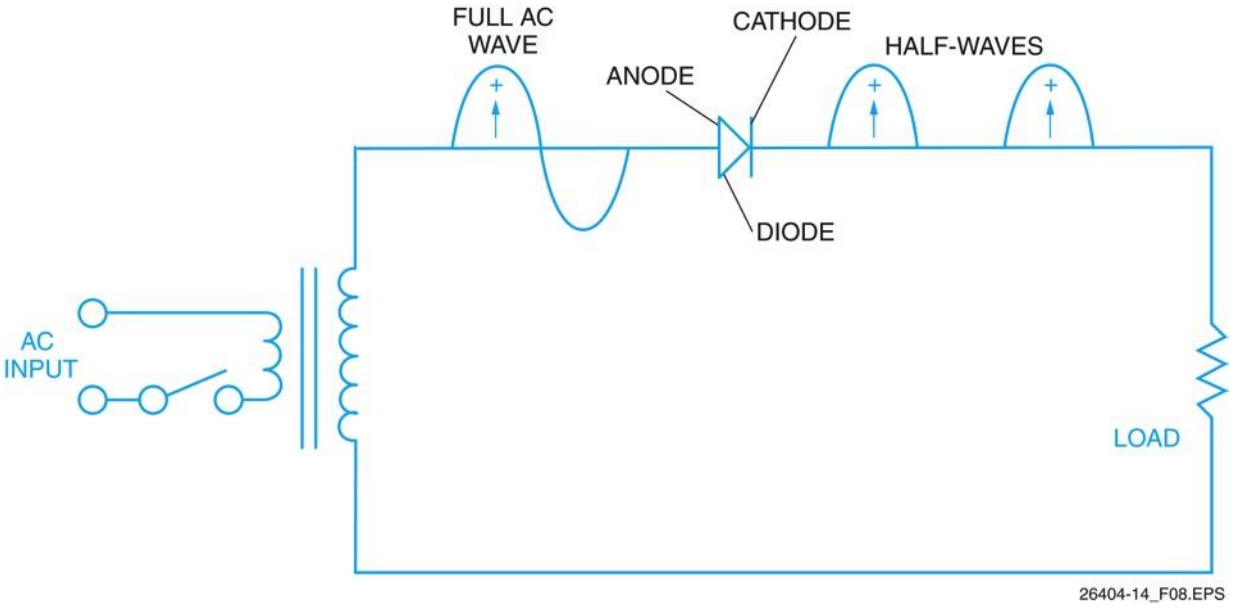
Forward and Reverse Bias

- Current does not flow across a PN junction unless a voltage of the correct polarity is applied. This is known as forward bias.
- When a voltage of the opposite polarity is applied, no current will flow. This is known as reverse bias and can be used to create solid-state switching devices.



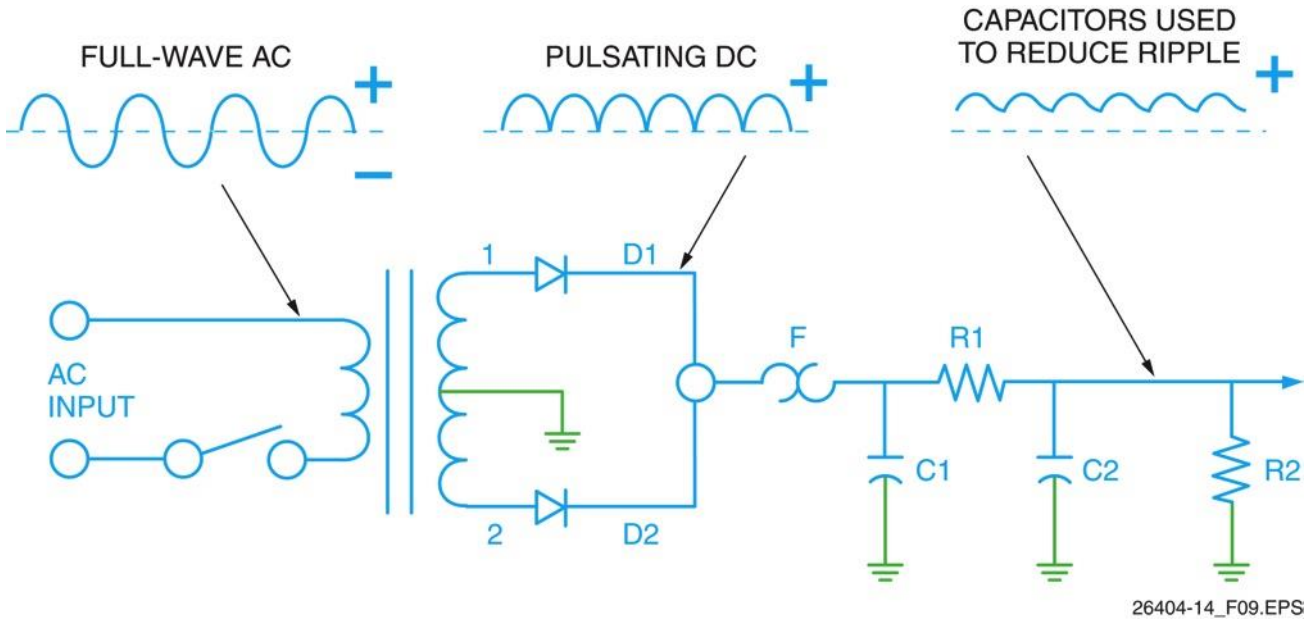
Half-Wave Rectifier

- In a half-wave rectifier, the single diode conducts current only when the AC applied to its anode is on its positive half-cycle.
- Half-wave rectifiers produce pulsating DC voltage.



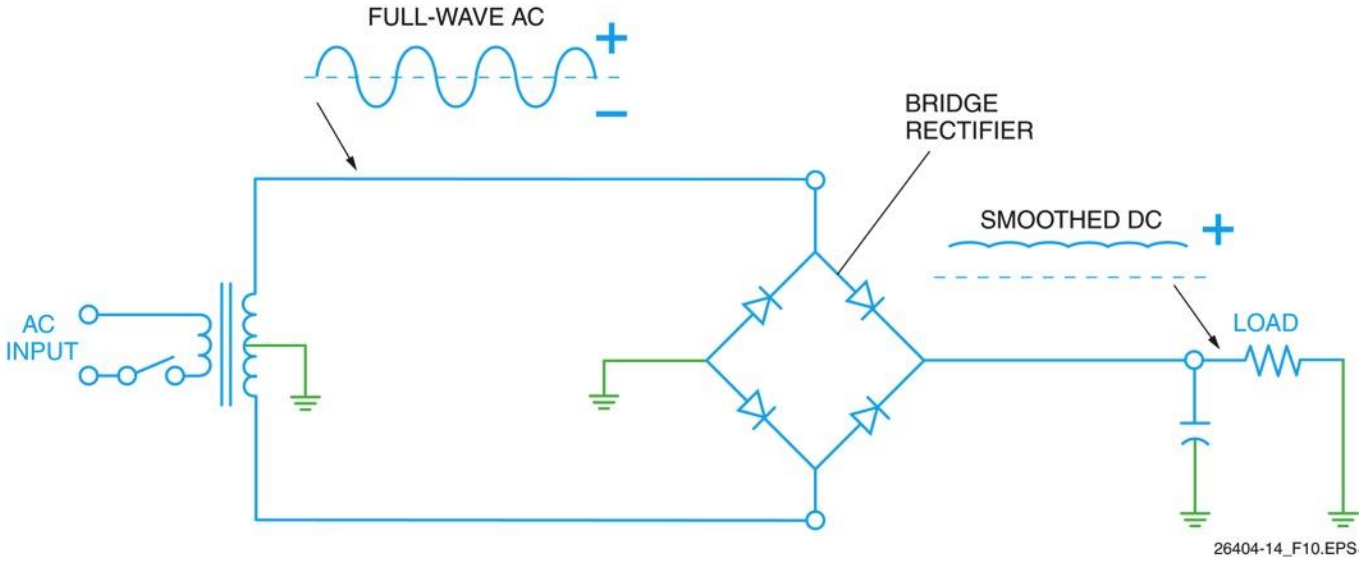
Full-Wave Rectifier

- In a full-wave rectifier, one of the diodes conducts on each half cycle of the AC input.
- Full-wave rectifiers produce a smoother pulsating DC voltage than half-wave rectifiers.



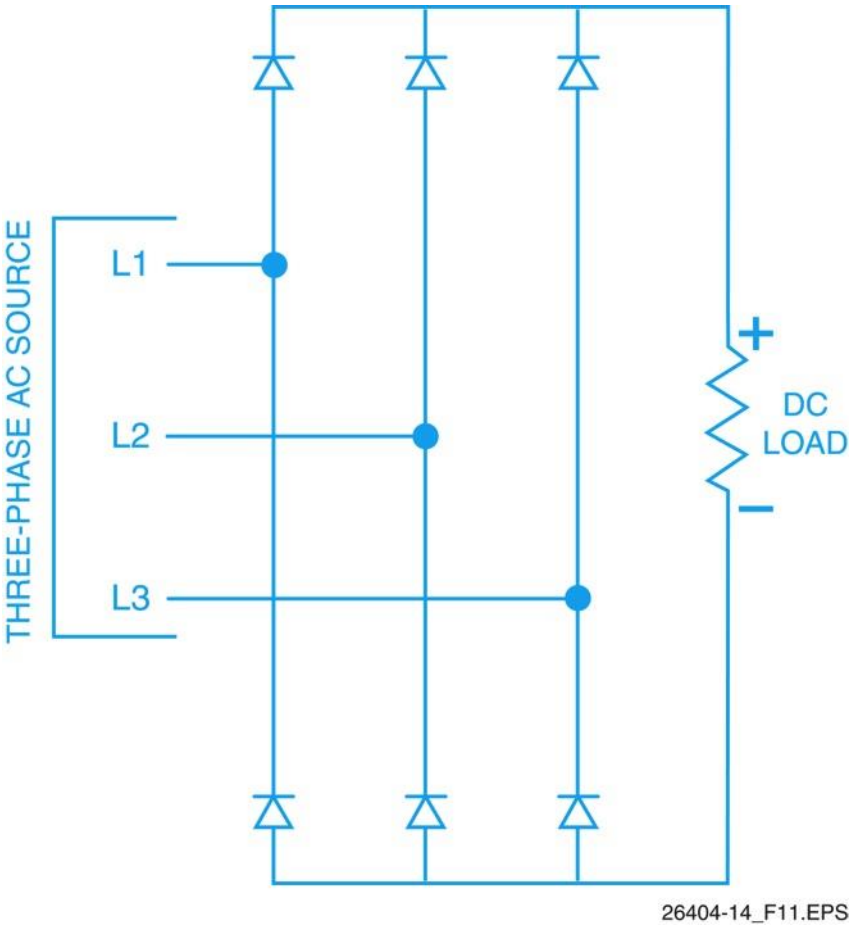
Bridge Rectifier

- In a bridge rectifier, two of the four diodes conduct on each half cycle of the AC input.
- Bridge rectifiers produce the smoothest DC output and are the most common type of rectifier used in electronic circuits.



Three-Phase Rectifier

A three-phase rectifier contains six diodes to produce high-efficiency DC power.



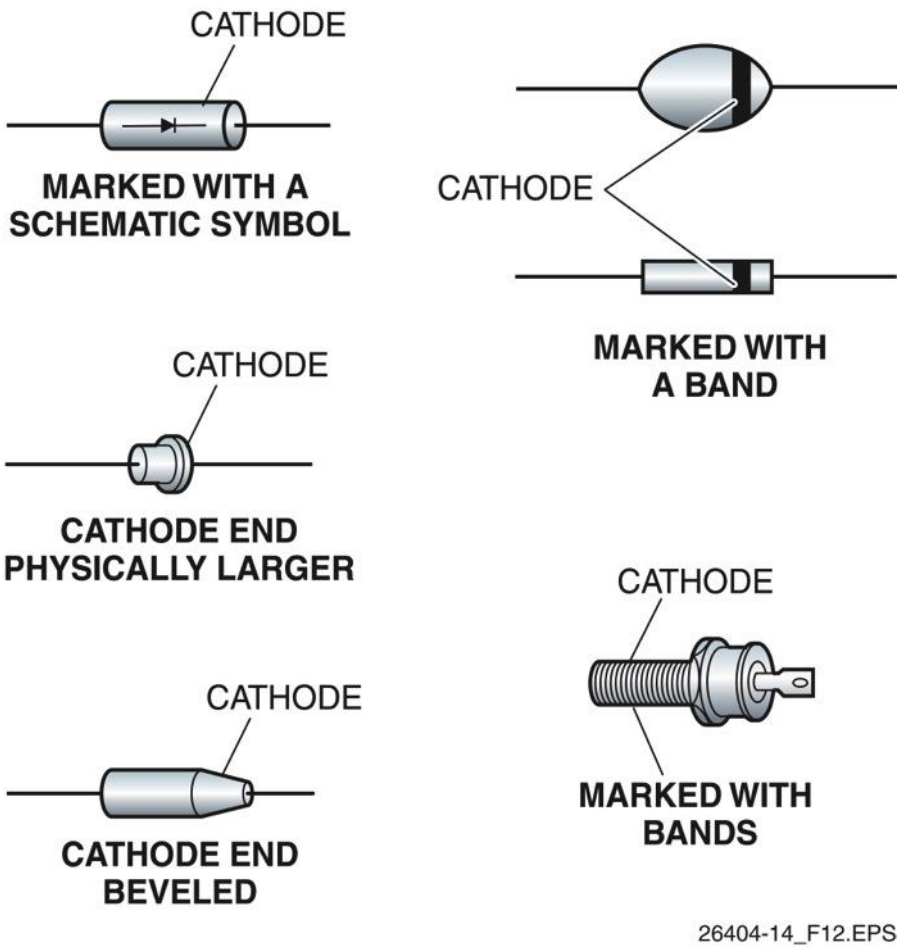
Diode Characteristics

Type	Peak Inverse Voltage (PIV)	Ambient Temperature Range (°C)	Forward Peak (mA)	Current Average (mA)	Capacitance (µF)
1N34A	60	–50 to +75	150	50	150
1N58A	100	–50 to +75	150	50	150

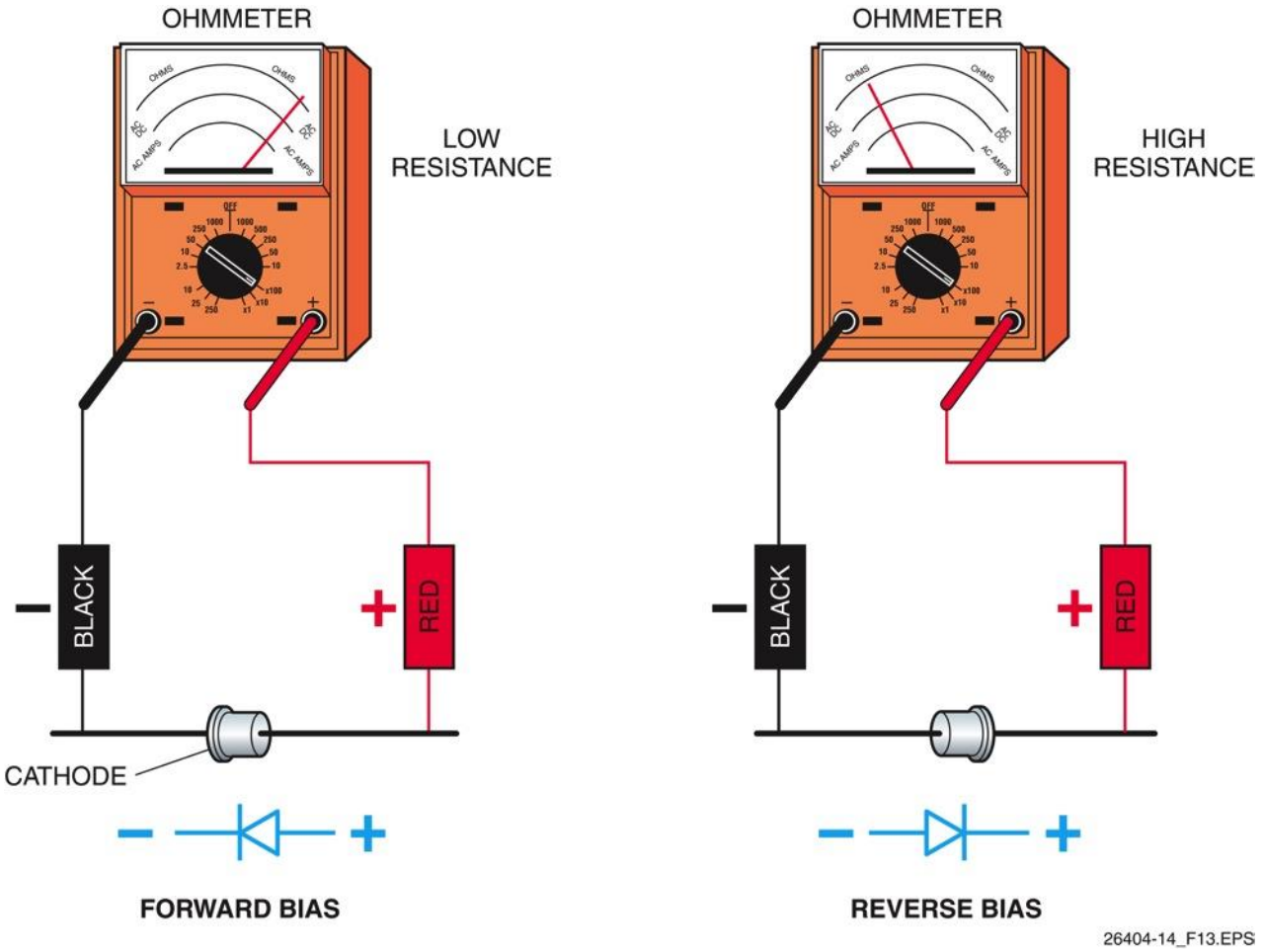
- Manufacturer catalogs list diode characteristics using standard designations.
- The peak inverse value (PIV) is the reverse bias at which avalanche breakover occurs.
- There are two main types of diodes: silicon and germanium. Silicon diodes generally have higher PIV/current ratings and wider temperature ranges than germanium diodes.

Methods Used to Identify Diodes

- The cathode end of a diode may be marked with a symbol or band, or be either beveled or physically larger than the anode end.
- When in doubt, the polarity of a diode may be checked using an ohmmeter.

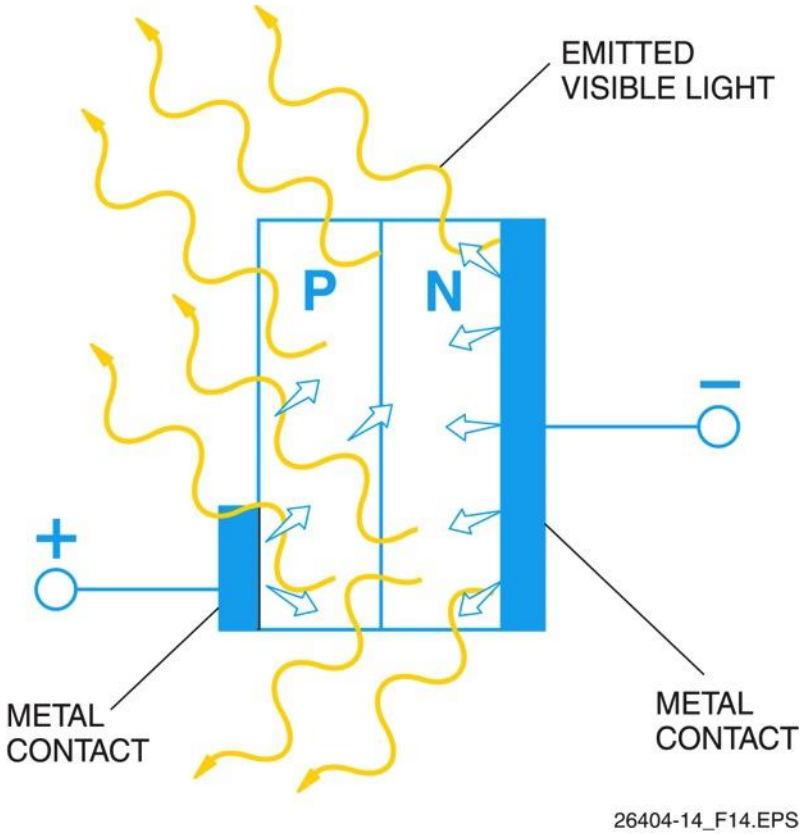


Testing a Diode with an Ohmmeter



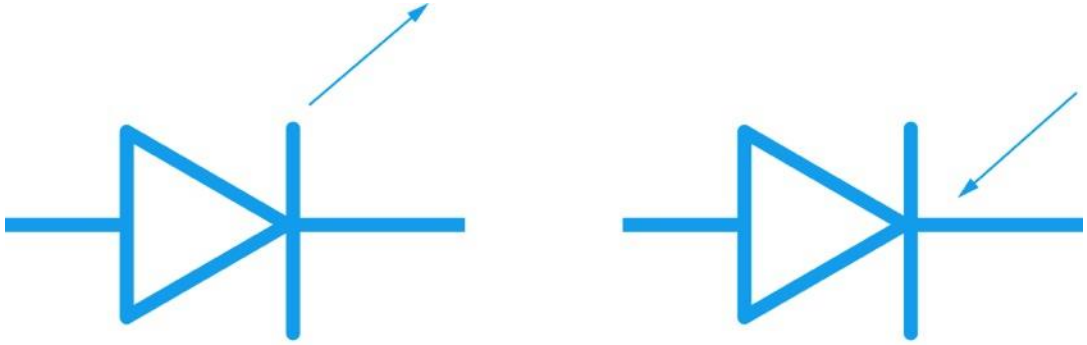
Light-Emitting Diodes

- All energized forward bias diodes release photons in a process known as electroluminescence. A light-emitting diode (LED) produces enough light energy to be used as a light source.
- LEDs are used in lighting applications as well as for pilot lights on electronic circuits and in numerical displays.



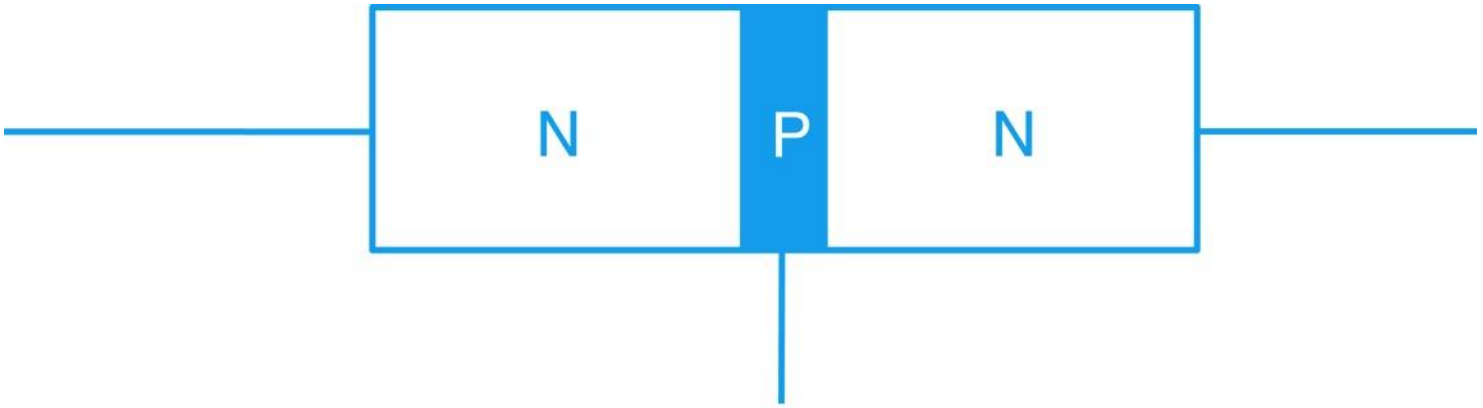
Schematic Symbols for an LED and Photo Diode

- Unlike an LED, a photo diode requires light in order to operate.
- Photo diodes are used as switches; light energizes the circuit, while the absence of light opens the circuit.



Transistors

- A transistor is made by joining three layers of semiconductor material, forming either an NPN or PNP type. Transistors made in this way are also known as junction transistors.
- Control voltages are applied to the center layer to produce the desired output voltage characteristics.



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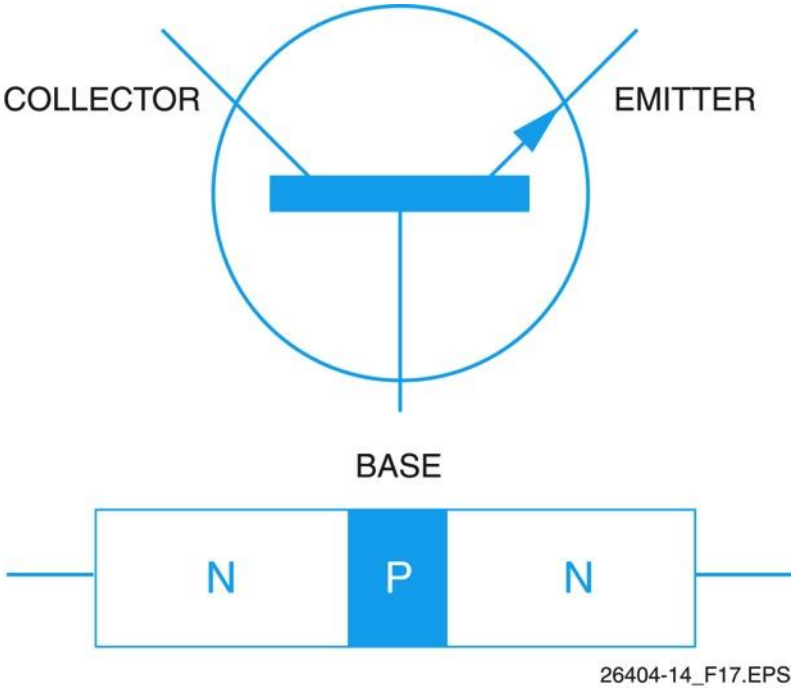
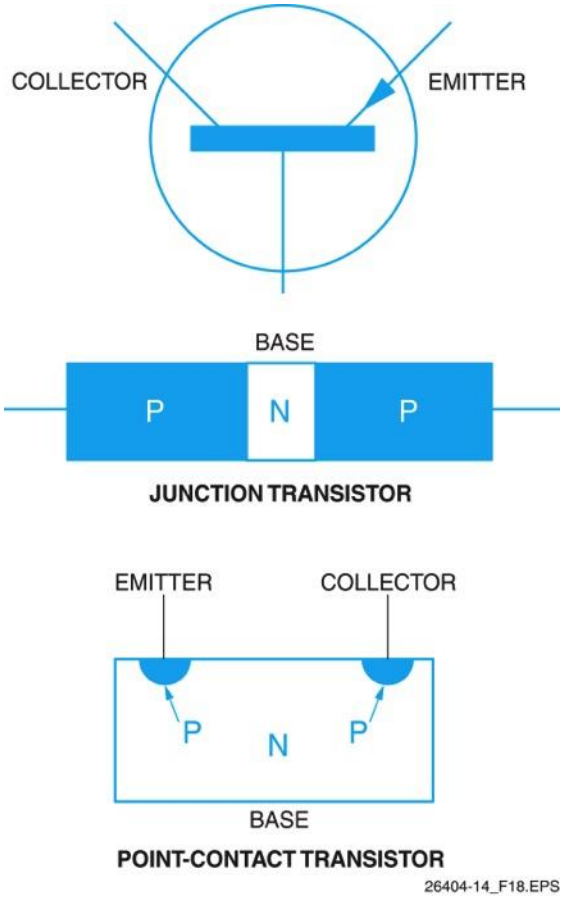
NPN Transistor Characteristics and Schematic Symbol

- Junction transistors contain three basic components: the base, emitter, and collector.
- In an NPN transistor, the current flow is in the opposite direction of the arrow on the schematic symbol. Since the arrow points away from the base, current flow is from the emitter (N-type) material to the base (P-type) material.



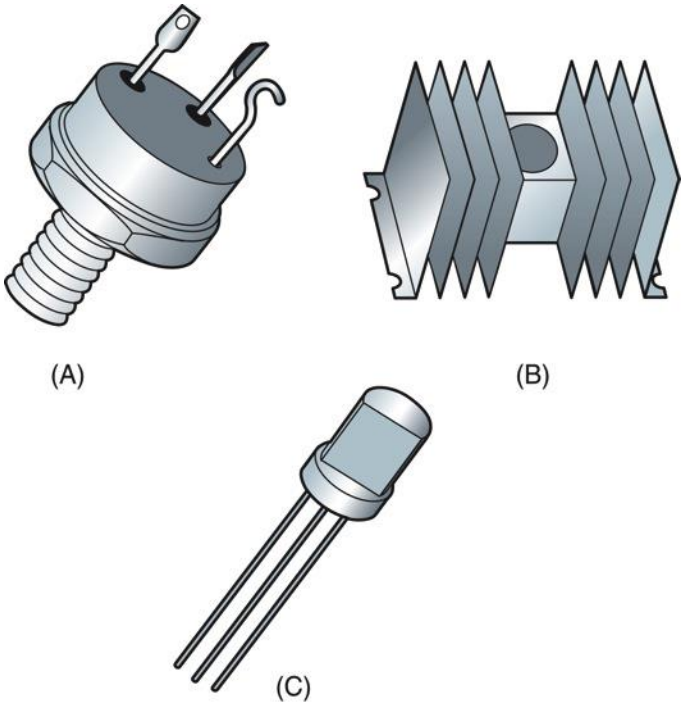
PNP Transistor Characteristics and Schematic Symbol

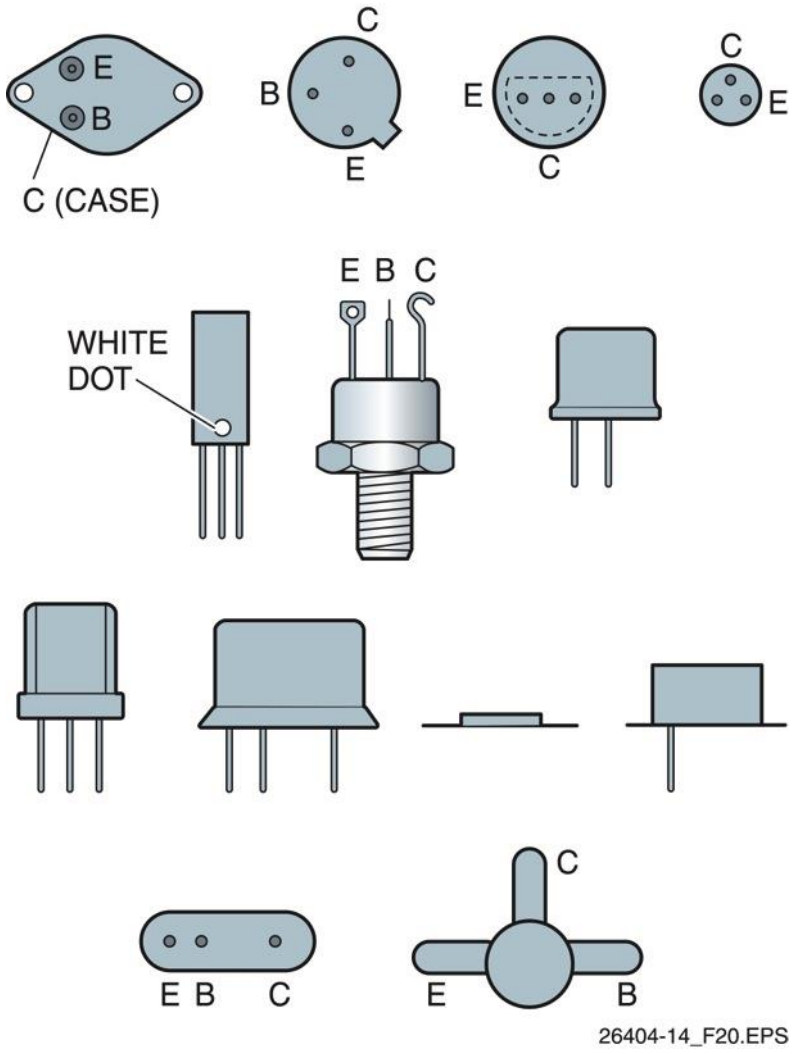
- In a PNP transistor, the current flow is in the opposite direction of the arrow on the schematic symbol. Since the arrow points toward the base, current flow is from the base (N-type) material to the emitter (P-type) material.
- Point-contact transistors are similar in operation to other junction transistors.



Various Transistors

Transistors with studs and heat sinks are high-power devices, while those with a small can or plastic body (top hat) are low- to medium-power devices.





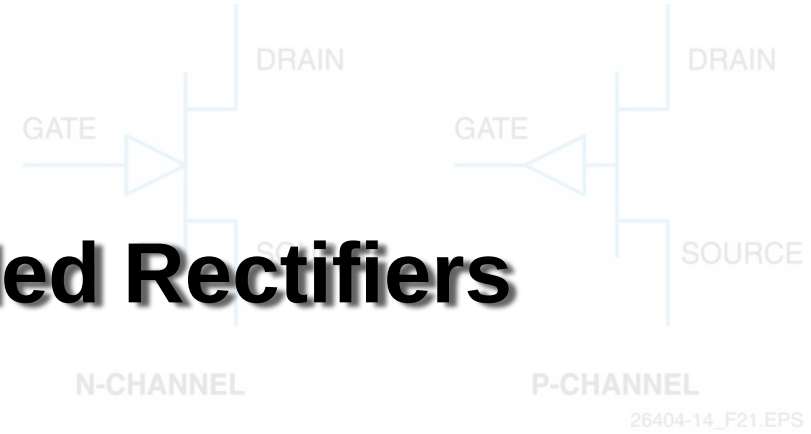
Lead Identification of Transistors

Transistors typically include markings to indicate which leads are connected to the base, emitter, and collector of the transmitter. The type of markings vary based on the transistor type.

Next Session…

Silicon-Controlled Rectifiers

- Field-effect transistors (FETs) control the flow of current with an electric field. There are two types of FETs: junction field-effect transistors (JFETs) and metal-oxide semiconductor field-effect transistors (MOSFETs).
- JFETs can be either N-channel or P-channel types.

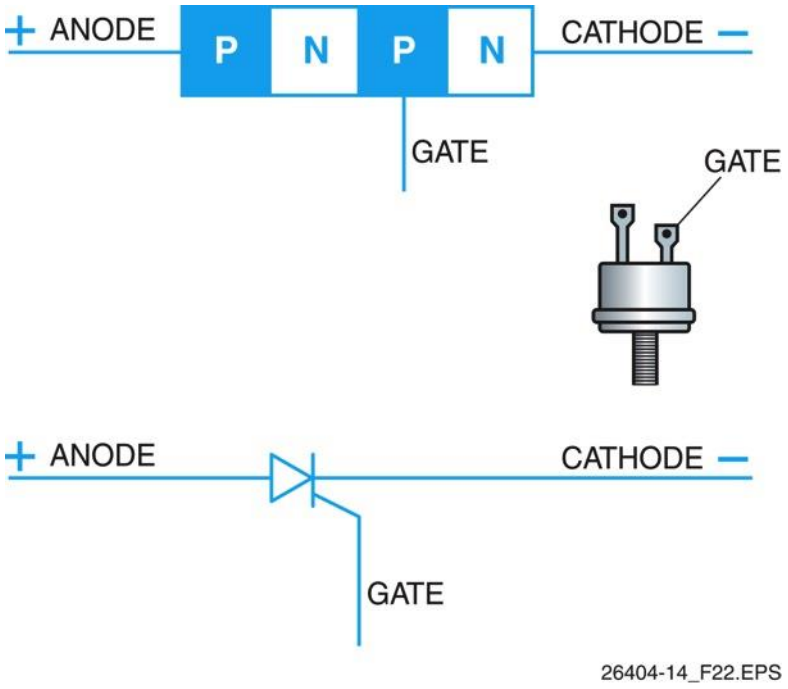


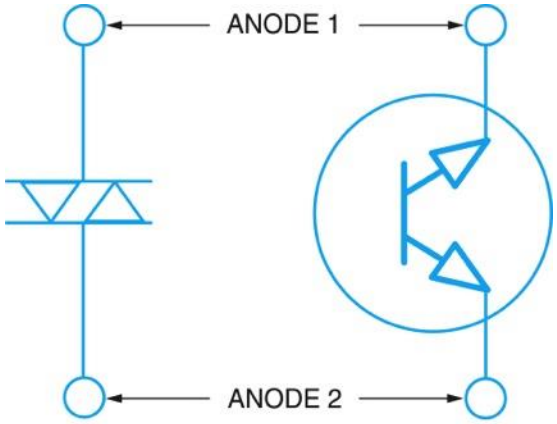
Performance Task

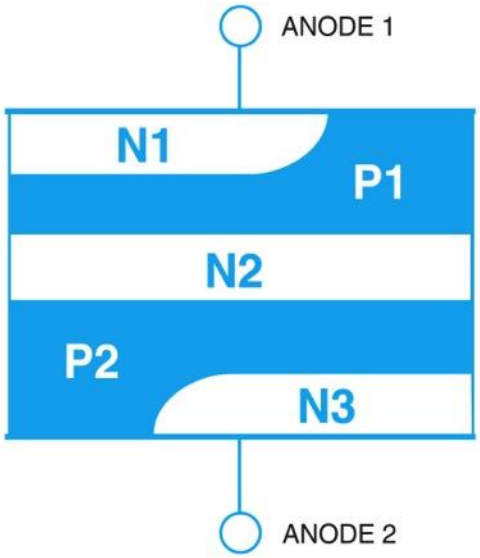
This session will conclude with trainees testing a transistor to determine whether it is an NPN or PNP.

Silicon-Controlled Rectifiers

- Silicon-controlled rectifiers (SCRs), diacs, and triacs are all types of thyristors. Thyristors are used for AC power and motor speed control, emergency lighting circuits, dimmers, and ignition systems.
- Like a diode, current flows through an SCR in one direction, but SCR operation requires the addition of a gate voltage.







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Diacs

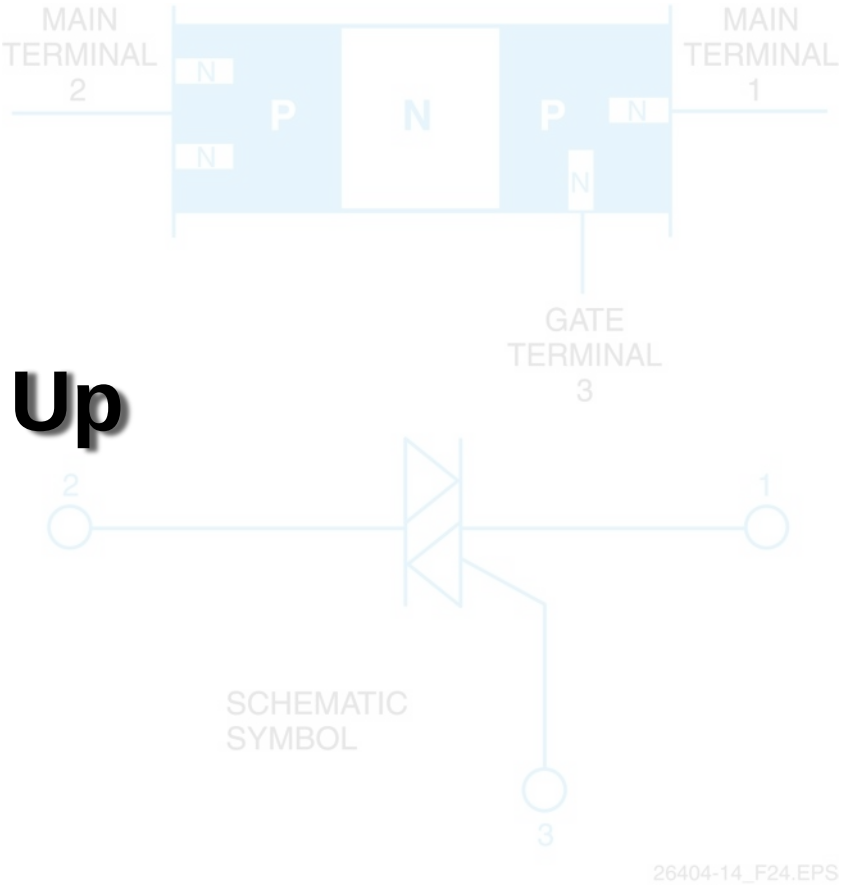
- Diacs are AC switches that are often used to control triacs. A diac is not gated, but will not conduct until the applied voltage exceeds a certain level.
- Gates can be depicted using either of the schematic symbols shown here.

Performance Task

Have the trainees identify the cathode on three different styles of SCRs, using the shape or markings for identification.

Next Session…

- A diode is like two SCRs turned in opposite directions with a common gate. However, the gate voltage does not have to exceed the breakover voltage in order to conduct.
- Like SCRs, triacs are used in phase control applications to control the power applied to loads. They are also used in lighting dimmers and photocell switches.



Wrap Up

Wrap Up

3-2-1

3 – Write 3 important things learned during class

2 – Write 2 questions you have about the material

1 – Write 1 thought you had about the material

Next Session…

MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.