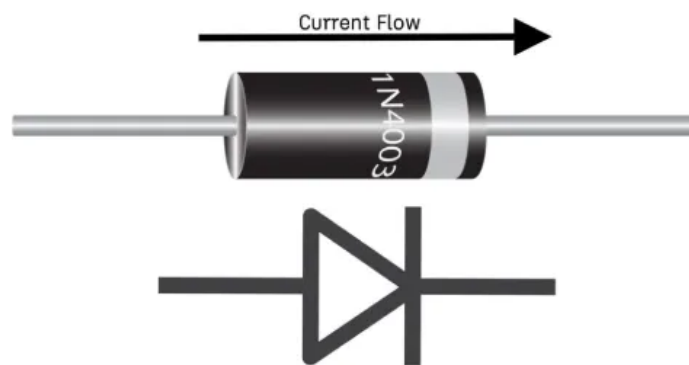


# BASIC ELECTRONIC DEVICES

## DIODE & RELATED TOPICS

A diode is a two-terminal semiconductor device that allows current to flow primarily in one direction (forward bias), acting like a one-way valve for electricity. It has an anode (positive side) and a cathode (negative side).



Key aspects of a diode:

### **Directional current flow:**

Diodes allow current to flow from the anode to the cathode when forward biased (positive voltage on the anode) and block current flow in the reverse direction (positive voltage on the cathode).

### **Rectification:**

Diodes are often used as rectifiers to convert alternating current (AC) into direct current (DC) by allowing only one half of the AC waveform to pass through.

### **Types:**

Diodes come in various types, including PN junction diodes (common and versatile), Schottky barrier diodes, and specialized types like Zener diodes (for voltage regulation).

### **Applications:**

Diodes are used in a wide range of applications, including:

- **Rectifying AC to DC:** Converting AC power to DC for devices that require it.
- **Filtering signals:** Removing unwanted frequency components from signals.
- **Protecting circuits:** Zener diodes can help prevent overvoltage.
- **Light-emitting diodes (LEDs):** A type of diode that emits light when current flows through it.

**Materials:**

Diodes are commonly made from semiconductor materials like silicon and germanium.

**1. What is the function of a diode in a circuit?**

It allows current to flow in only one direction (forward bias) and blocks it in the opposite (reverse bias).

**2. What is a PN junction?**

A junction formed between p-type and n-type semiconductors; it's the basic structure of a diode.

**3. What is the significance of knee voltage?**

It's the forward voltage at which the diode starts conducting significantly (typically 0.7V for Si, 0.3V for Ge).

**4. What is the avalanche breakdown?**

It occurs when a high reverse voltage causes a large number of carriers due to impact ionization, leading to a sudden increase in reverse current.

**5. What is the role of a diode in a clipper and clamper circuit?**

- **Clipper:** Removes a portion of input signal above or below a set level.
- **Clamper:** Shifts the entire signal level without changing shape.

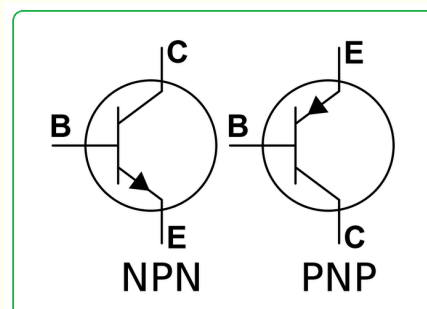
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**BJT & AMPLIFICATION BASICS**

A BJT (Bipolar Junction Transistor) is a three-terminal semiconductor device used for amplification and switching in electronic circuits. It consists of three layers of doped semiconductor material (two n-type and one p-type or vice versa), forming two p-n junctions. BJTs are categorized as either NPN or PNP, with the arrangement of the semiconductor layers distinguishing them.

**Key features of BJTs:**

- **Three terminals:** Emitter (E), Base (B), and Collector (C).
- **Current-controlled:** The current flow between the collector and emitter is



controlled by the current flowing through the base.

- **Amplification:** BJTs can amplify or magnify electrical signals, making them suitable for use in amplifiers.
- **Switching:** BJTs can act as electronic switches, turning a circuit on or off.
- **Types:** NPN and PNP BJTs.

How it works:

**NPN Transistor:**

A small current at the base terminal controls a larger current between the collector and emitter.

**PNP Transistor:**

A small current at the base terminal controls a larger current between the collector and emitter, but in the opposite direction compared to NPN.

**Biasing:**

BJTs require a proper DC voltage to operate, which is achieved by biasing the base-emitter and base-collector junctions.

QUESTIONS:

**6. How does a BJT amplify current?**

A small base current controls a much larger collector current, based on current gain ( $\beta$ ). Amplification occurs in active region.

**7. What is Early Effect in BJT?**

Also called base-width modulation; as collector voltage increases, effective base width decreases, affecting  $I_c$ .

**8. What is thermal runaway in BJTs?**

As temperature increases, leakage current increases, raising collector current and further increasing temperature. This positive feedback can destroy the transistor.

**9. What are the different configurations of BJT?**

- **Common Base:** Low input impedance, high output impedance
- **Common Emitter:** Most used, good voltage/current gain
- **Common Collector (Emitter Follower):** High input impedance, unity voltage gain

**10. What is a Darlington pair?**

Two BJTs connected to provide very high current gain, used in power amplifiers.

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## MOSFET & FET BASICS

### 11. How does a MOSFET operate?

It uses an electric field to control the conductivity of a channel. Gate voltage creates/controls a channel for current between source and drain.

### 12. What is channel length modulation in MOSFET?

A decrease in effective channel length due to increase in  $V_{ds}$  in saturation region, similar to Early Effect in BJT.

### 13. Difference between N-channel and P-channel MOSFETs?

- **N-channel:** Better electron mobility, faster, used more often.
- **P-channel:** Uses holes as carriers, slower, used in complementary logic (CMOS).

### 14. What is CMOS technology?

Uses both NMOS and PMOS transistors to implement logic gates with low power consumption and high noise immunity.

### 15. What is subthreshold conduction in MOSFET?

A small current that flows even when  $V_{gs} < V_{th}$  due to weak inversion; significant in low-power designs.

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## GENERAL SEMICONDUCTOR DEVICES & THEORY

### 16. What is a unipolar vs bipolar device?

- **Unipolar (e.g., MOSFET):** Current conduction due to one type of charge carrier.
- **Bipolar (e.g., BJT):** Conduction by both electrons and holes.

### 17. What is a Schottky diode?

A diode with low forward voltage drop ( $\sim 0.2V$ ) and fast switching. Used in high-speed and RF applications.

### 18. What is a photodiode?

A diode that generates current when exposed to light. Used in sensors, solar cells, optical communication.

### 19. What is a tunnel diode?

A diode with negative resistance due to quantum tunneling. Used in microwave oscillators and fast switching.

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**20. What is the function of a current mirror?**

A circuit that copies current from one active device to another. Used in analog ICs to bias amplifiers.

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**PRACTICAL APPLICATIONS & CIRCUITS**

**21. What are the applications of MOSFETs in power electronics?**

Used in SMPS, motor drives, inverters, and DC-DC converters due to high efficiency and fast switching.

**22. How is MOSFET used as a switch?**

In saturation mode, it acts like a closed switch (ON), and in cut-off mode, like an open switch (OFF).

**23. Why is gate voltage important in MOSFET?**

It controls the conductivity of the channel. No gate current flows due to the oxide layer, making it voltage-controlled.

**24. Explain latch-up in CMOS.**

A parasitic thyristor structure forms in CMOS circuits, potentially causing short circuit and damage. Avoided by guard rings and layout design.

**25. Why do we use heat sinks in power BJTs/MOSFETs?**

To dissipate heat generated during conduction and switching, ensuring reliability and preventing thermal runaway.