



# Diodes

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- Background and Usage

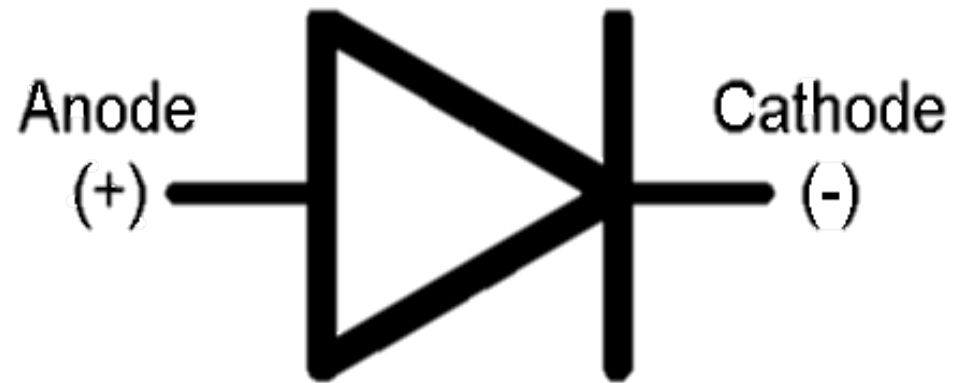
Overview:

- Definition and Introduction
- Ideal and Real Characteristics
- Current Voltage Relationship
- Types of Diodes
- Applications

# The World with Diodes

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- Why is it important and how can we look at it from the big picture?
- The one-way valve of electronics.

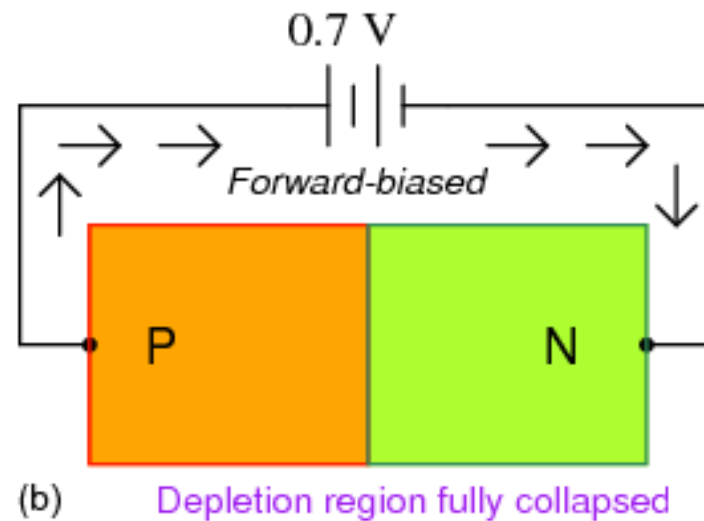
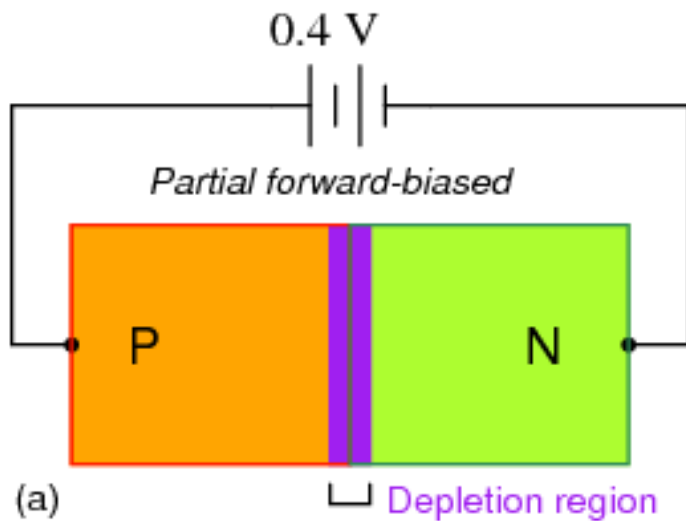
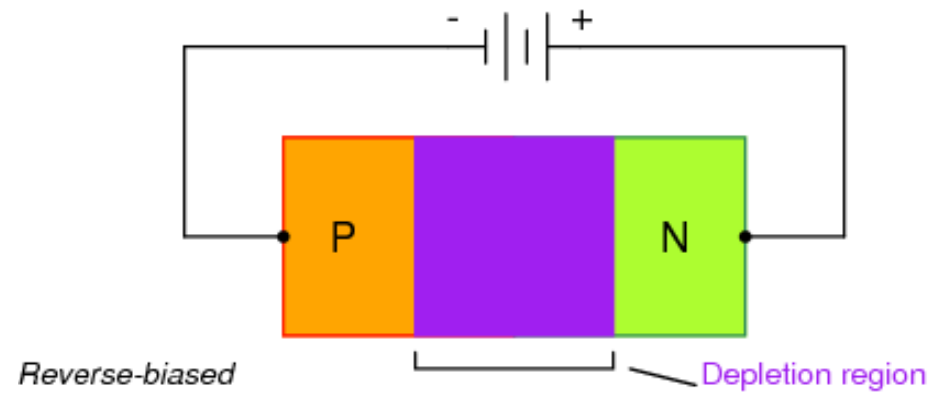
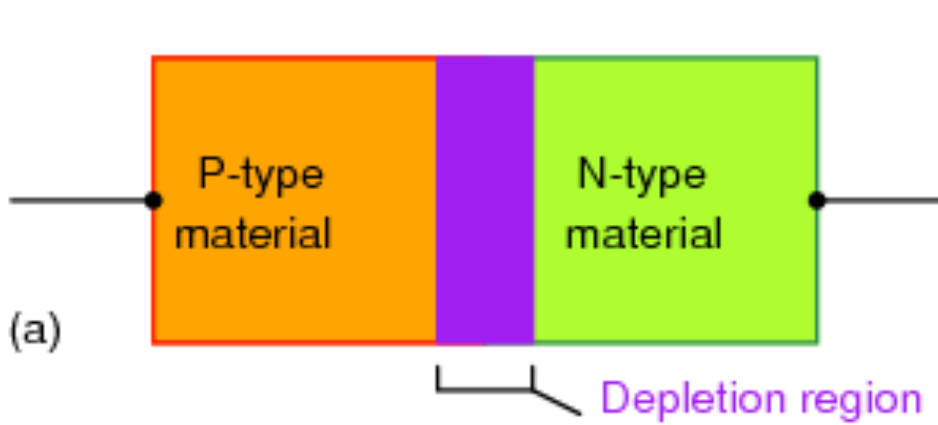


# The Purpose Of a Diode

# Ideal Diode Characteristics

- An ideal diode is to control the direction of current-flow.
- Short Circuit
- Forward Biasing
- Reverse Biasing

Operation Mode	On (Forward biased)	Off (Reverse biased)
Current Through	$I > 0$	$I = 0$
Voltage Across	$V = 0$	$V < 0$
Diode looks like	Short circuit	Open circuit



# The PN Region

$$I_D = I_S (e^{qV_D/NkT} - 1)$$

Where,

$I_D$  = Diode current in amps

$I_S$  = Saturation current in amps  
(typically  $1 \times 10^{-12}$  amps)

$e$  = Euler's constant ( $\sim 2.718281828$ )

$q$  = charge of electron ( $1.6 \times 10^{-19}$  coulombs)

$V_D$  = Voltage applied across diode in volts

$N$  = "Nonideality" or "emission" coefficient  
(typically between 1 and 2)

$k$  = Boltzmann's constant ( $1.38 \times 10^{-23}$ )

$T$  = Junction temperature in Kelvins

$$I_D = I_S (e^{V_D/0.026} - 1)$$

Where,

$I_D$  = Diode current in amps

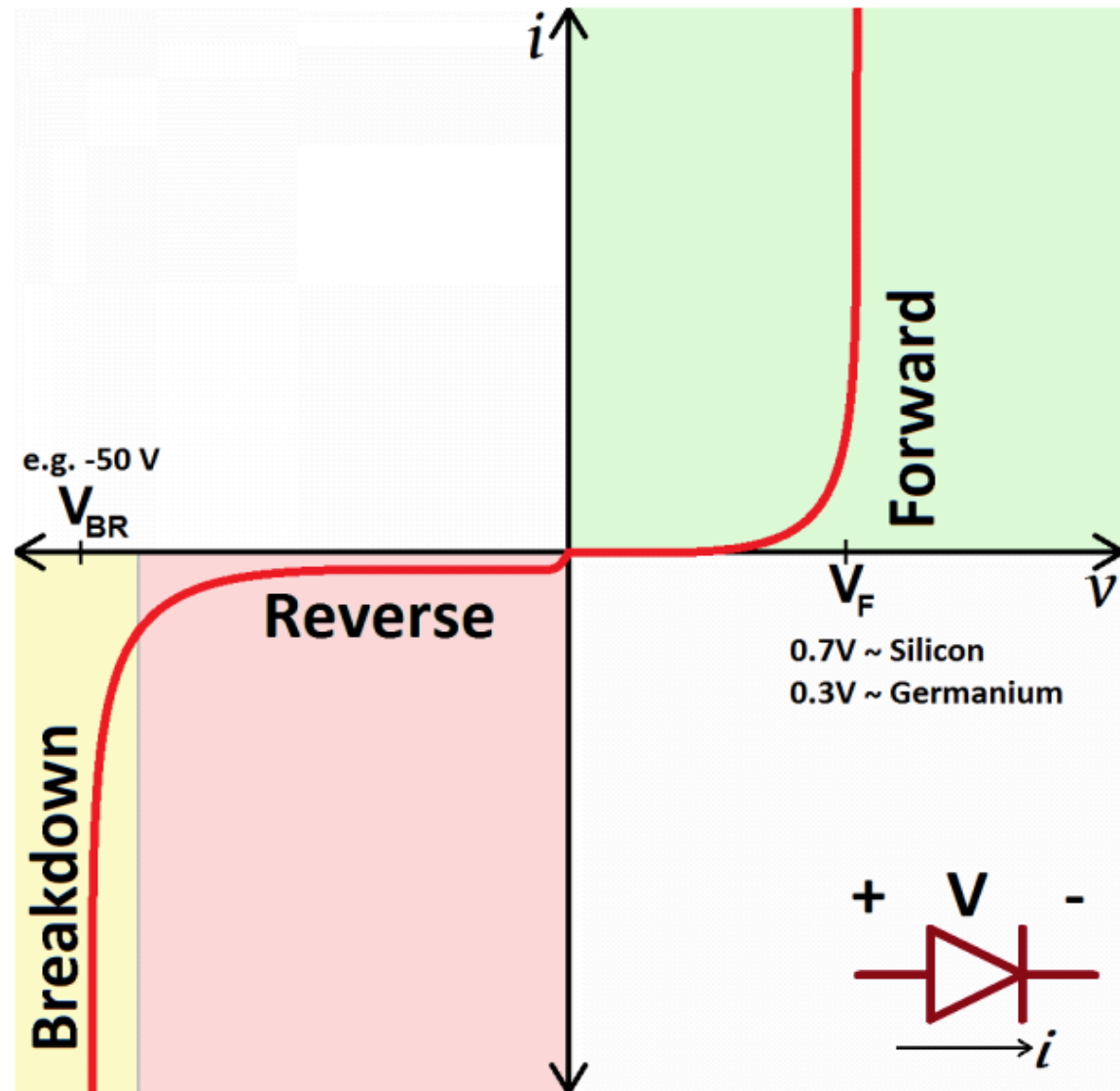
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$e$  = Euler's Number ( $\sim 2.718281828$ )

$V_D$  = Voltage applied across diode in volts

# Diode Equation

- Non Linear
- Forward Voltage
- Breakdown Voltage



# Current Voltage Relationship



# **TYPES OF DIODES**



## Normal Diode

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- The most basic.
- They usually have a medium-high forward voltage drop and a low maximum current rating

## Schottky Diode

- Smaller forward voltage drop
- Large breakdown voltage
- Limiting losses, when every last bit of voltage is important.

# Types Of Diodes

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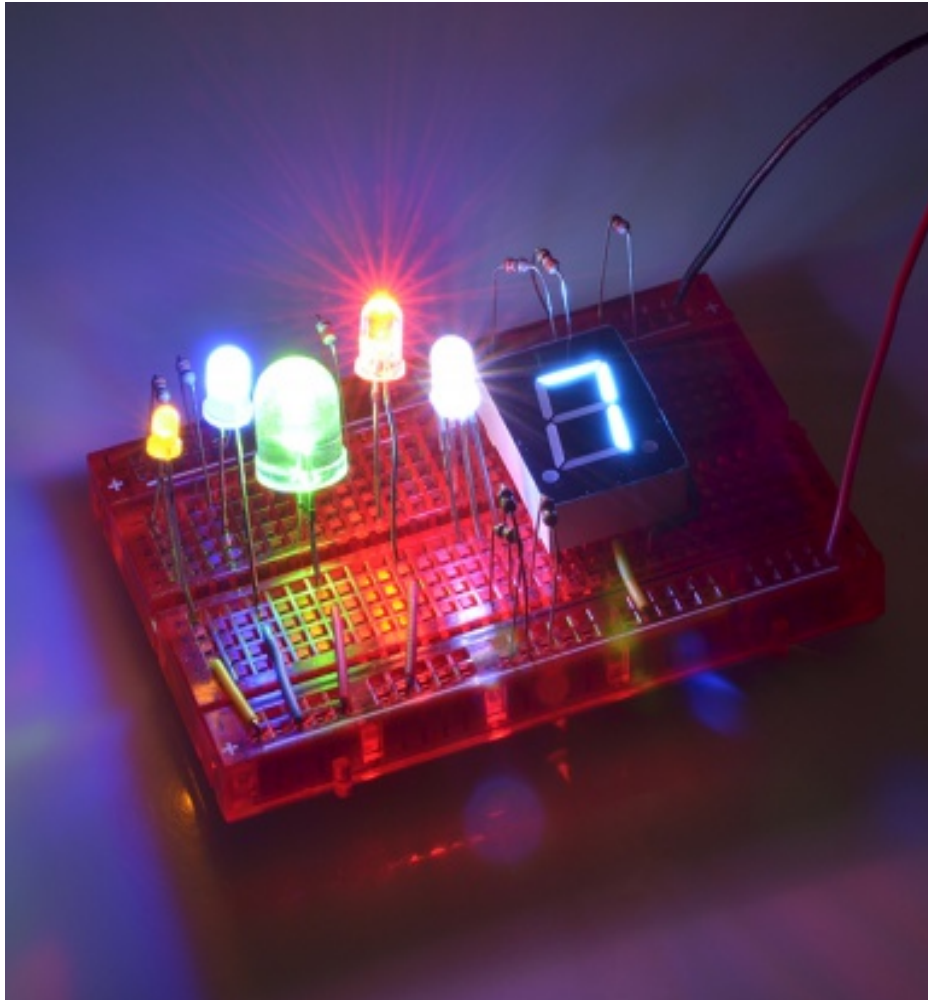
## Power Diode

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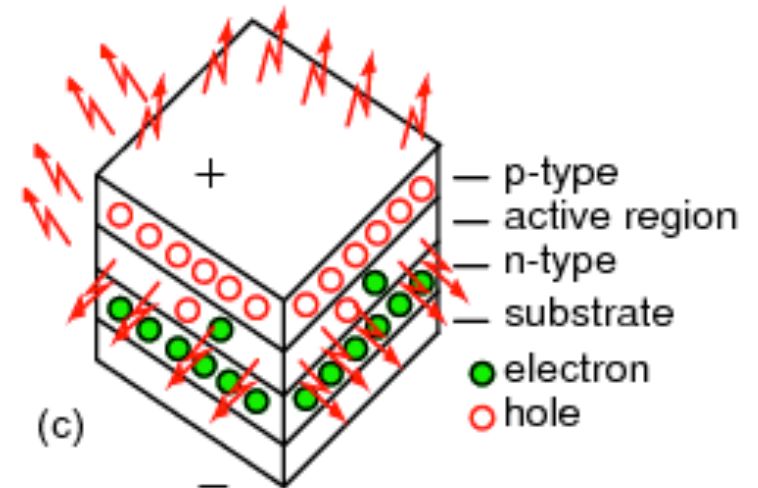
- Standard diode with a much higher maximum current rating.
- This higher current rating usually comes at the cost of a larger forward voltage

## Zener Diode

- Intentionally conduct reverse current.
- Very precise breakdown voltage, called the Zener breakdown voltage
- When enough current runs in reverse through the Zener, the voltage drop across it will hold steady at the breakdown voltage.



- Whenever electrons fall from a higher energy level to a lower energy level they emit specific-frequency radiant energy
- Electroluminescence



# Types Of Diode: LED

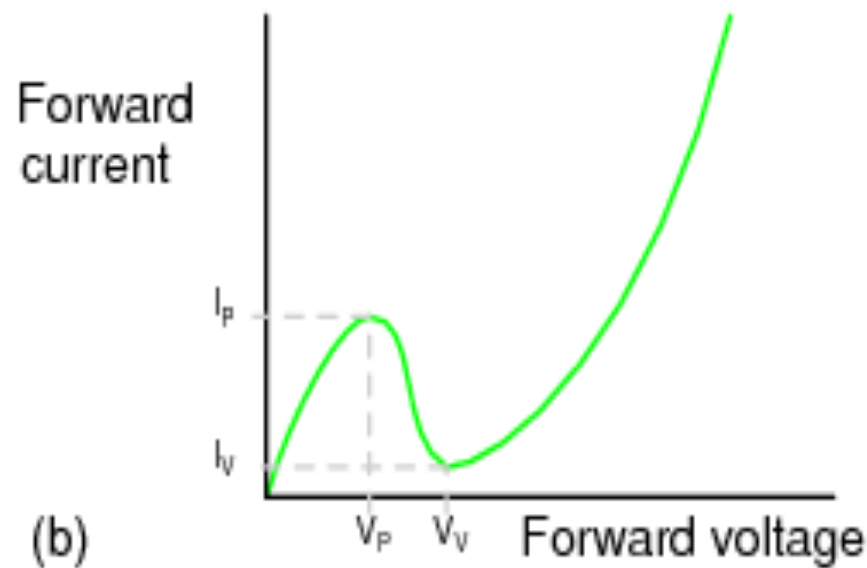
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- Resonant Tunneling
- Peak Current and Valley Current
- Negative Resistance

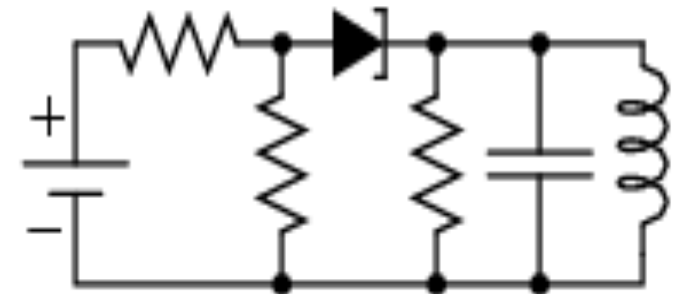
*Tunnel diode*



(a)

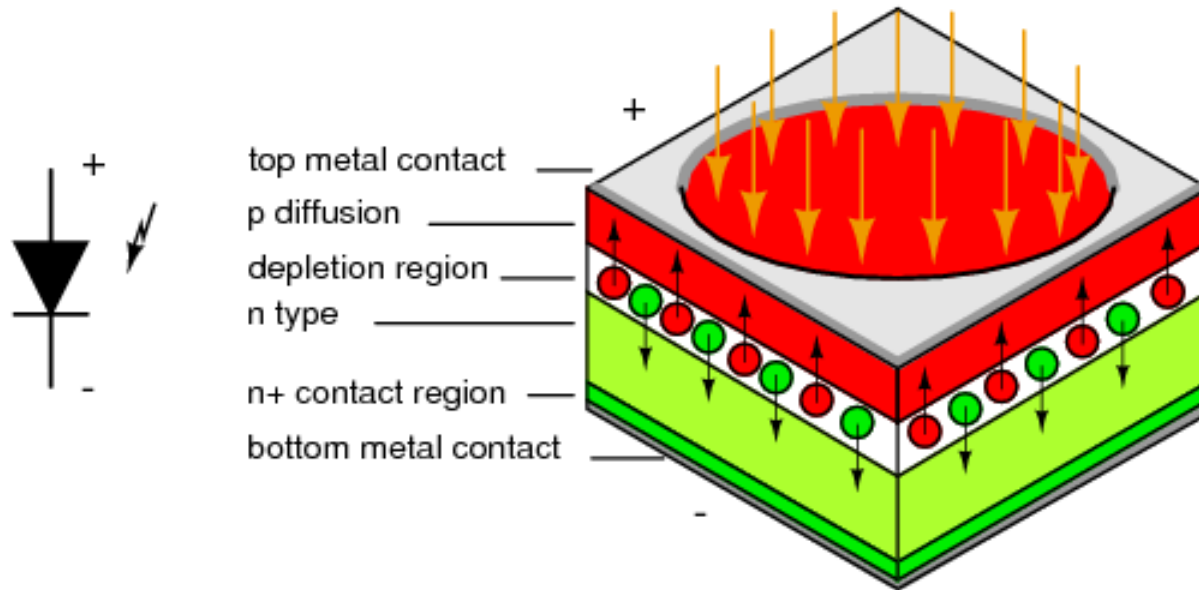


(b)

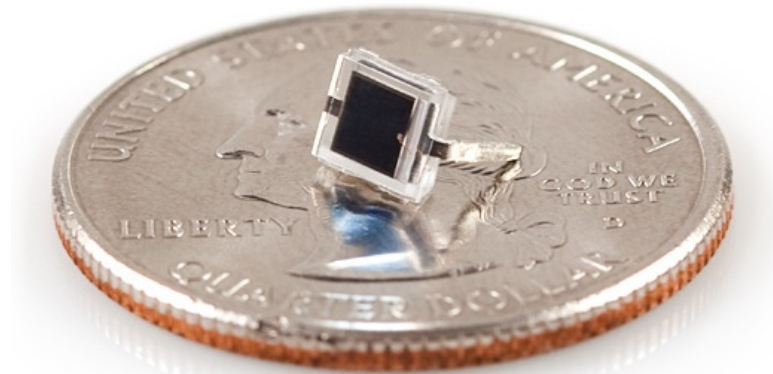


(c)

# Types Of Diode: Tunneling



- Electron current flow in response to manipulation of light.
- Solar Cells



# Types Of Diode: Photodiode

- Rectifiers
  - alternating current (AC) to direct current (DC).
- Current Protection/ Voltage Spike Stoppage
  - ensures that current can only flow in the positive direction, and the power supply only applies a positive voltage to your circuit
- Logic Gates
- Light and Power

# Applications and Conclusion

- C. R. Hampton, "Introduction to Diodes and Rectifiers: Diodes and Rectifiers - electronics textbook," in allaboutcircuits.com. [Online]. Available: <http://www.allaboutcircuits.com/textbook/semiconductors/chpt-3/introduction-to-diodes-and-rectifiers/>. Accessed: Nov. 12, 2016.
- Jimbo, "Diodes," in learn.sparkfun.com. [Online]. Available: <https://learn.sparkfun.com/tutorials/diodes>. Accessed: Nov. 12, 2016.
- S. Mubeena, Administrator, and C. Cheru, "AVR," in Diodes, Electronics Hub, 2015. [Online]. Available: [http://www.electronicshub.org/types-of-diodes/#Tunnel\\_Diode](http://www.electronicshub.org/types-of-diodes/#Tunnel_Diode). Accessed: Nov. 15, 2016.

# Sources: IEEE Format