

Section 24

Bipolar Junction Transistor - Fundamentals

24.2 Band Diagram in Equilibrium

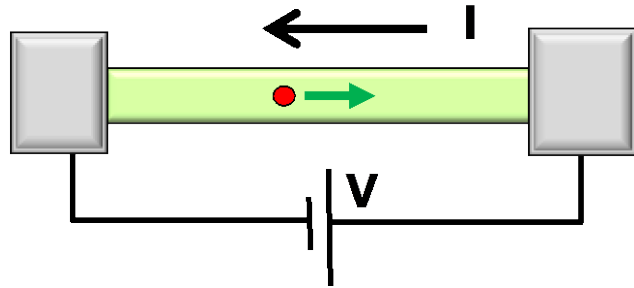
Gerhard Klimeck
gekco@purdue.edu



School of Electrical and
Computer Engineering

Section 24

Bipolar Junction Transistor - Fundamentals

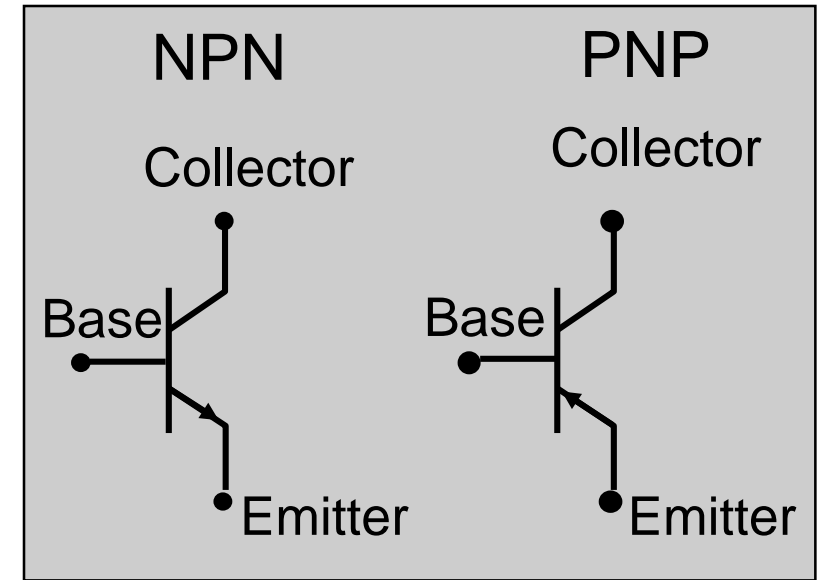


$$I = G \times V$$

$$= q \times n \times v \times A$$

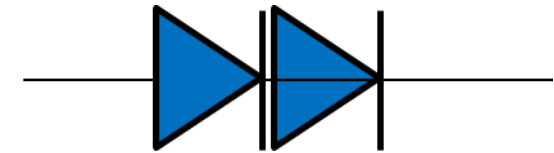
↑ charge density
 ↑ velocity
 area

- > • 24.1 Introduction
- > • 24.2 Band Diagram in Equilibrium
- > • 24.3 Currents in BJTs
- > • 24.4 Ebers Moll Model



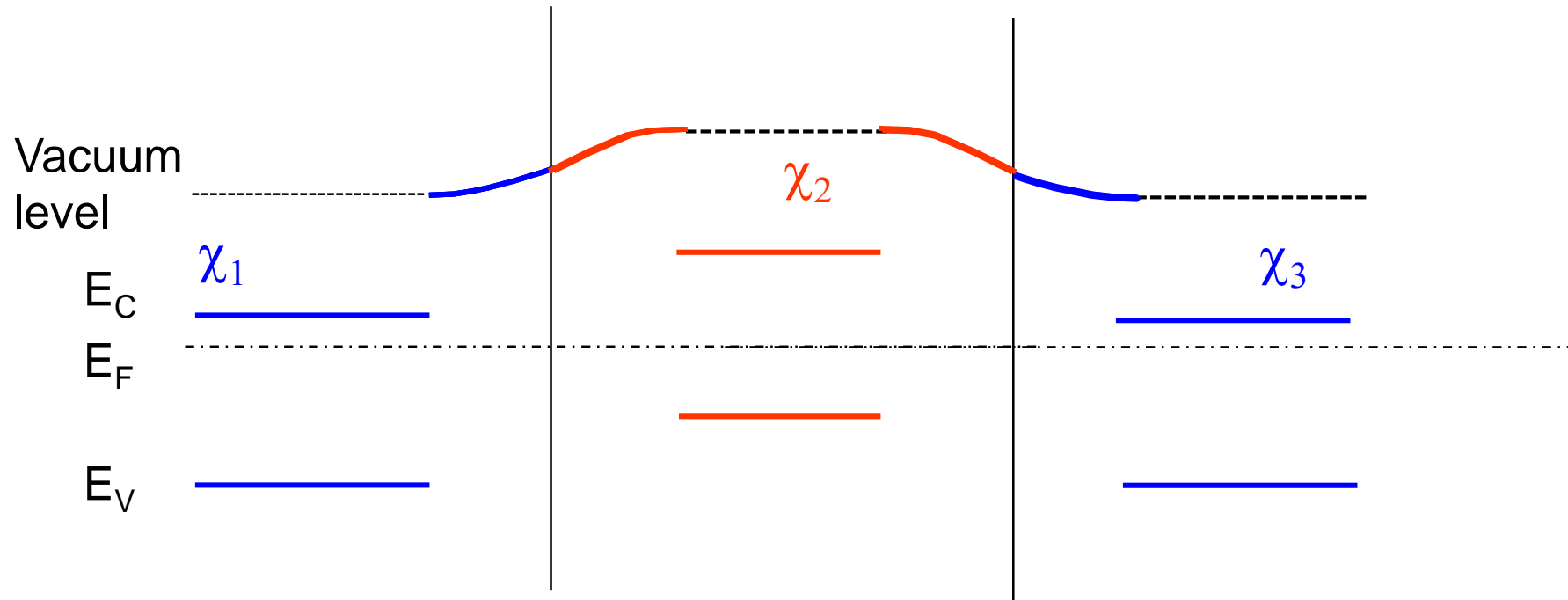
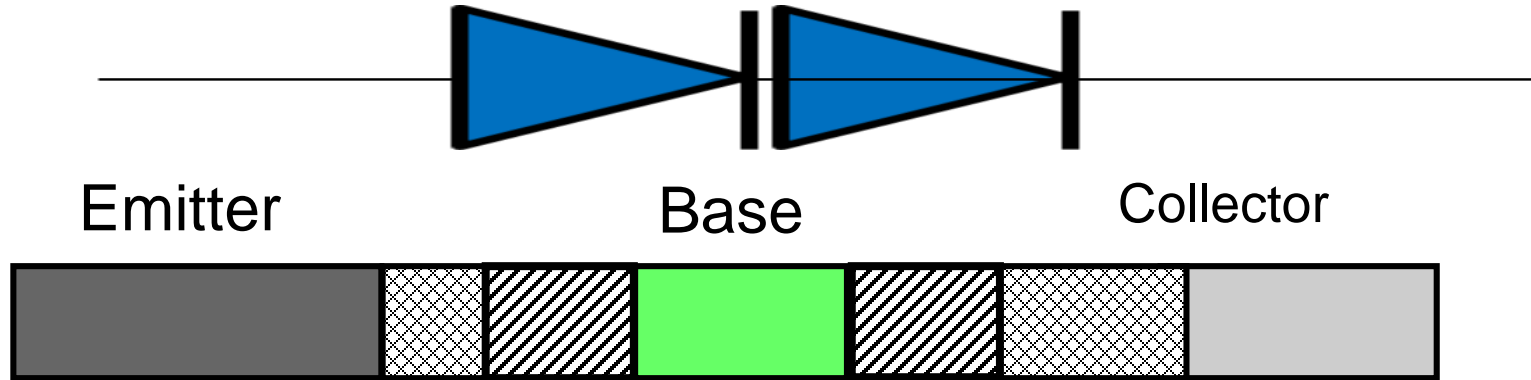
Equilibrium

$$\nabla \cdot D = q(p - n + N_D^+ - N_A^-)$$

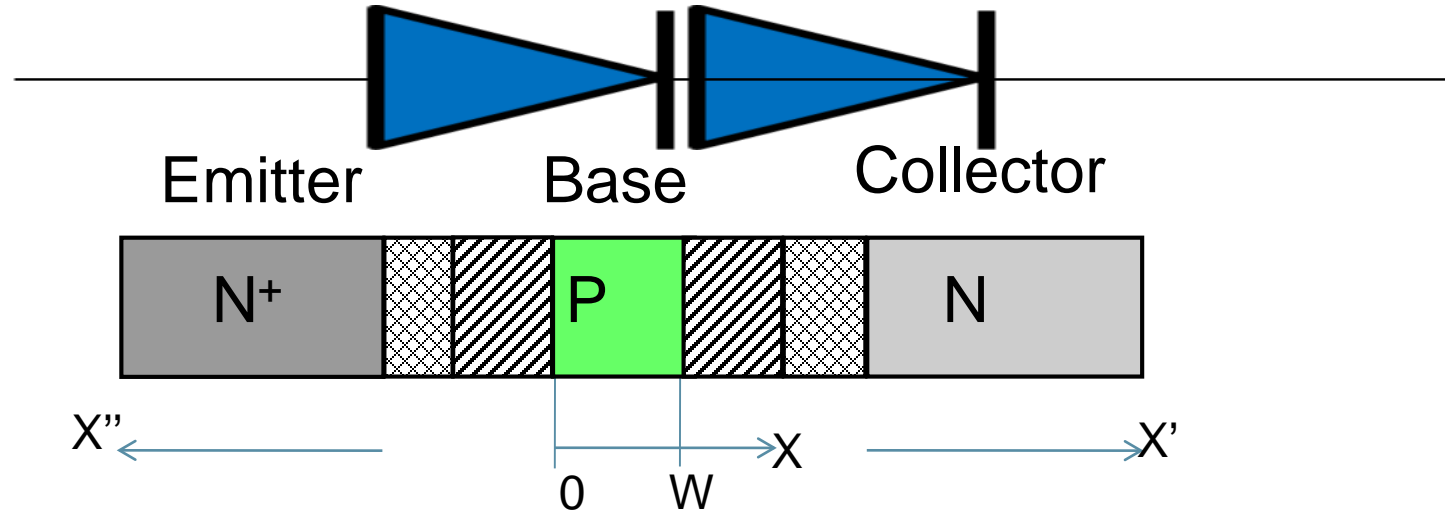


Band Diagram at Equilibrium (NPN Homojunction)

Two back to back p-n junctions



Coordinates and Convention



Doping
Minority carrier diffusion
Majority carriers

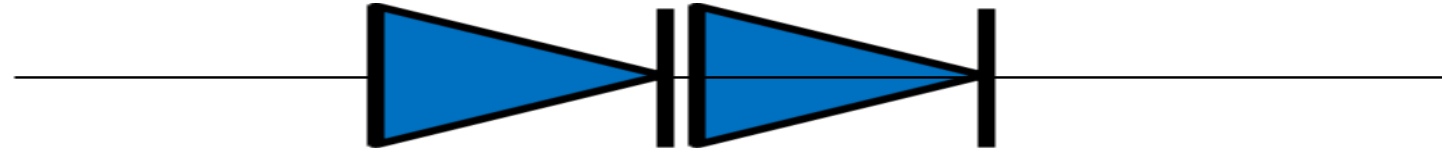
$$\begin{aligned} N_E &= N_{D,E} \\ D_E &= D_P \\ n_{E0} &= n_{p0} \end{aligned}$$

$$\begin{aligned} N_B &= N_{A,B} \\ D_B &= D_N \\ p_{B0} &= p_{n0} \end{aligned}$$

$$\begin{aligned} N_C &= N_{D,C} \\ D_C &= D_P \\ n_{C0} &= n_{p0} \end{aligned}$$

Electrostatics in Equilibrium

Two back to back p-n junctions

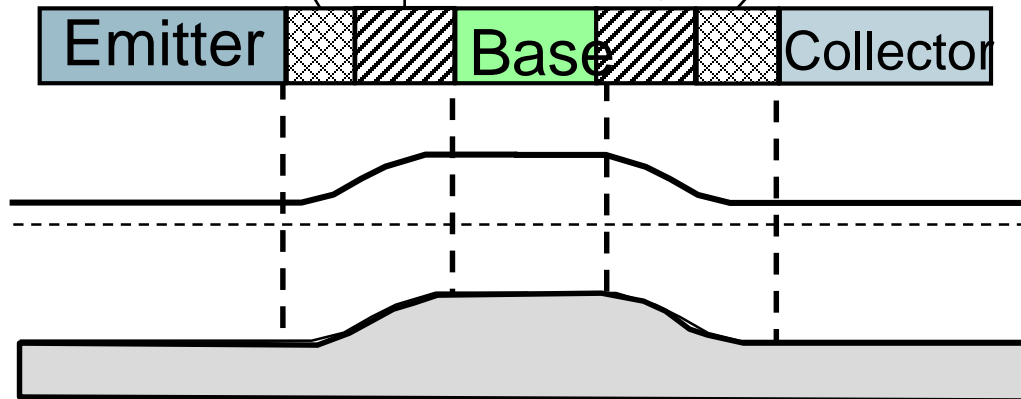


$$x_{p,BE} = \sqrt{\frac{2k_s \epsilon_0}{q} \frac{N_E}{N_B(N_E + N_B)} V_{bi}}$$

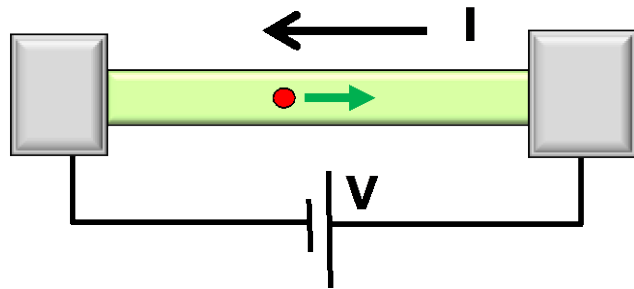
$$x_{p,BC} = \sqrt{\frac{2k_s \epsilon_0}{q} \frac{N_C}{N_B(N_C + N_B)} V_{bi}}$$

$$x_{n,E} = \sqrt{\frac{2k_s \epsilon_0}{q} \frac{N_B}{N_E(N_B + N_E)} V_{bi}}$$

$$x_{n,C} = \sqrt{\frac{2k_s \epsilon_0}{q} \frac{N_B}{N_C(N_C + N_B)} V_{bi}}$$



Section 24 Bipolar Junction Transistor - Fundamentals

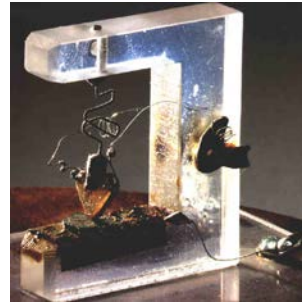


$$I = G \times V$$

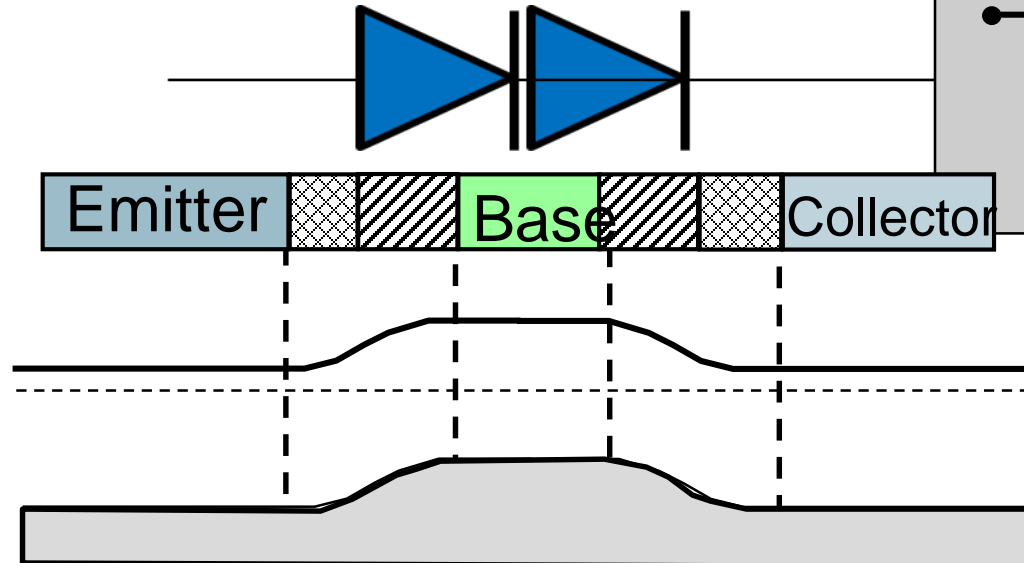
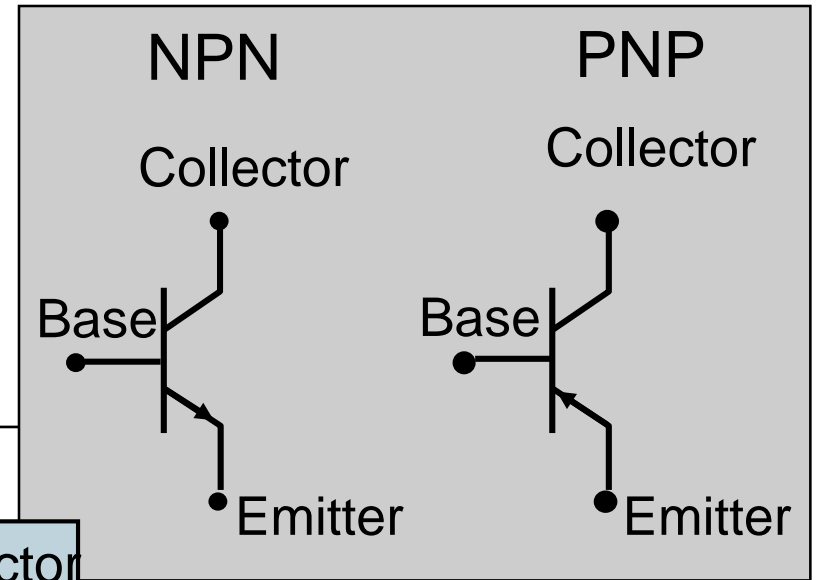
$$= q \times n \times v \times A$$

↑ charge density
 ↑ velocity
 area

- > • 24.1 Introduction
- > • 24.2 Band Diagram in Equilibrium
- > • 24.3 Currents in BJTs
- > • 24.4 Ebers Moll Model

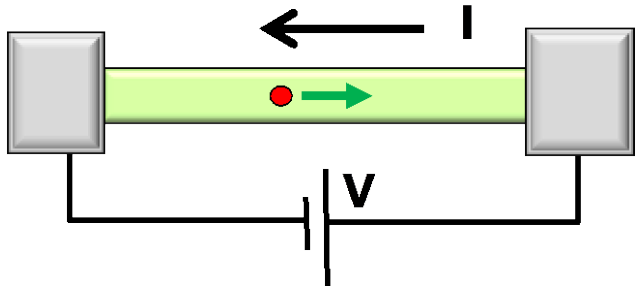


status



Section 24

Bipolar Junction Transistor - Fundamentals



$$I = G \times V$$

$$= q \times n \times v \times A$$

↑ charge density
 ↑ velocity
 area

- >
- >
- >
- >

- 24.1 Introduction
- 24.2 Band Diagram in Equilibrium
- 24.3 Currents in BJTs
- 24.4 Ebers Moll Model

