All of these share a feature with…

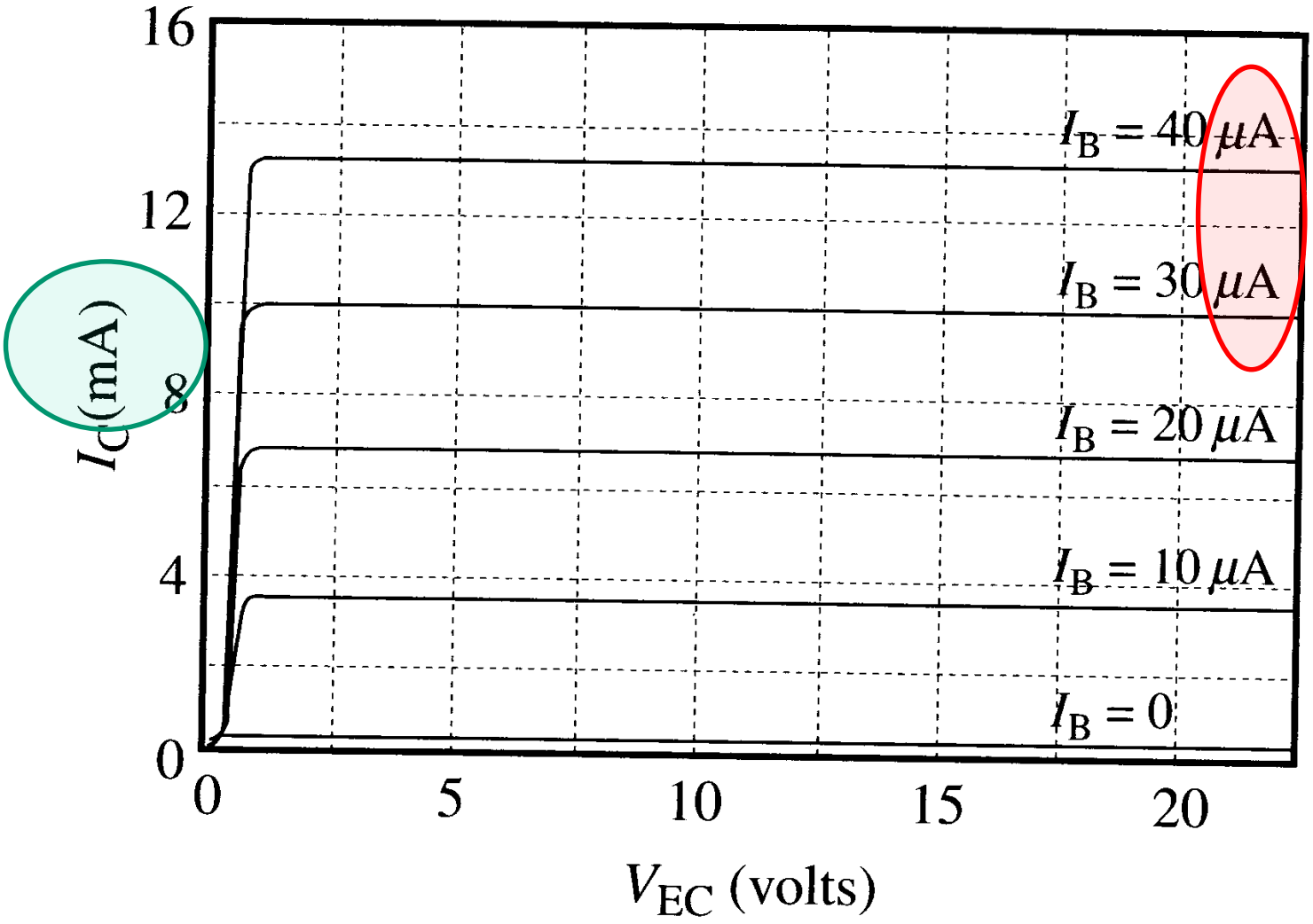
- Output current can toggle between large and small

  (Switching → Digital logic; create 0s and 1s)

- Small change in 'valve' (3rd terminal) creates Large change in output between 1st and 2nd terminal

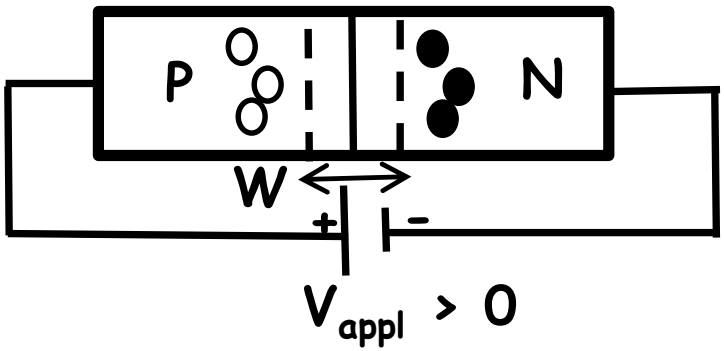
  (Amplification → Analog applications; Turn 0.5 → 50)

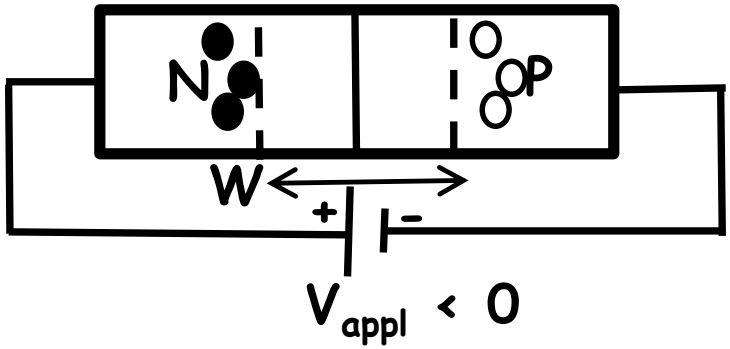
Example: BJT common emitter characteristics



Gain = 300

Recall p-n junction



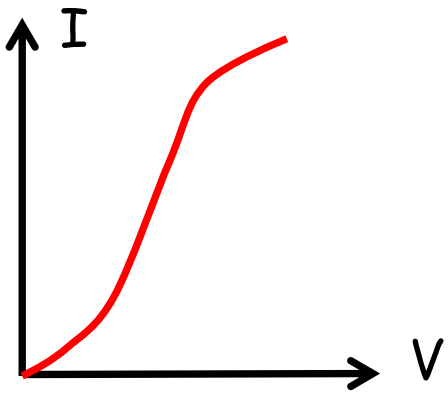


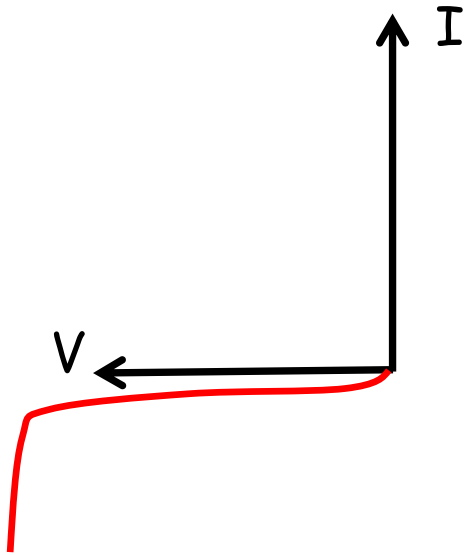
Forward bias, + on P, - on N
(Shrink W, V_{bi})

Allow holes to jump over barrier into N region as minority carriers

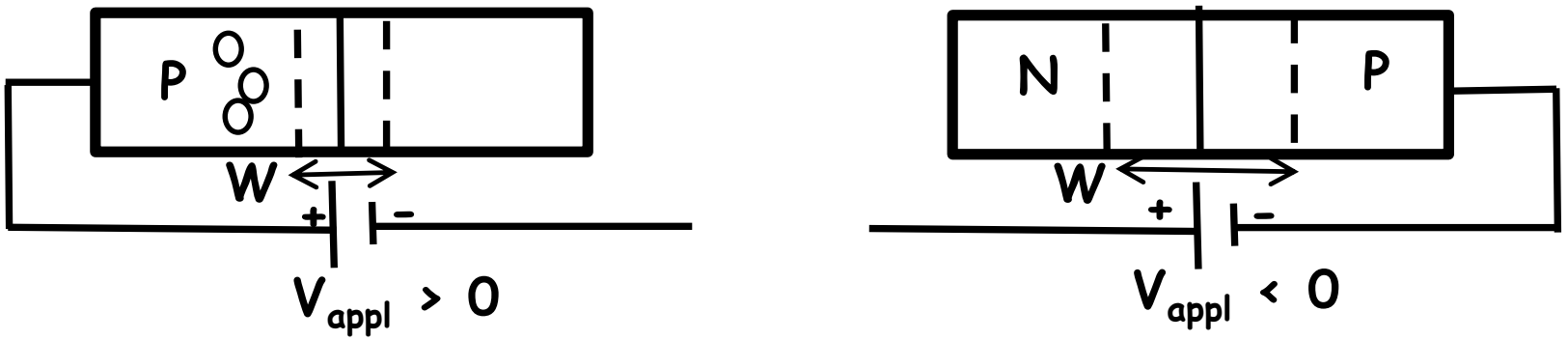
Reverse bias, + on N, - on P
(Expand W, V_{bi})

Remove holes and electrons away from depletion region





So if we combine these by fusing their terminals…

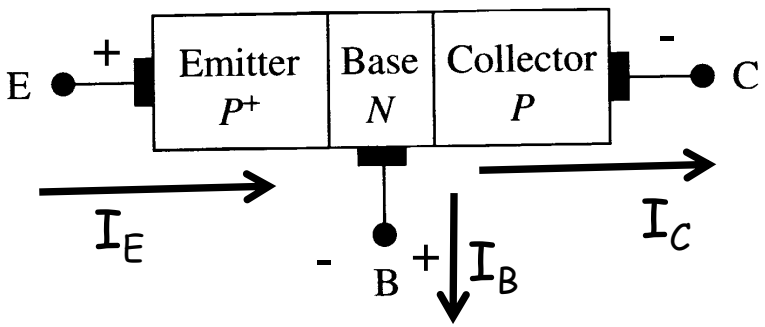


Holes from P region ("Emitter") of 1st PN junction driven by FB of 1st PN junction into central N region ("Base")

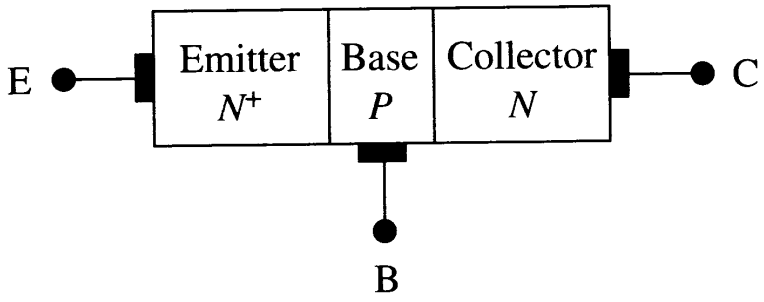
Driven by RB of 2nd PN junction from Base into P region of 2nd junction ("Collector")

- 1st region FB, 2nd RB
- If we want to worry about holes alone, need P+ on 1st region
- For holes to be removed by collector, base region must be thin

Bipolar Junction Transistors: Basics



(a) *pnp*

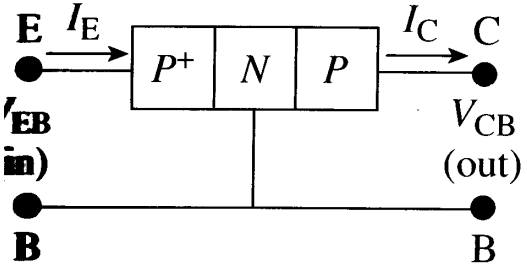


(b) *npn*

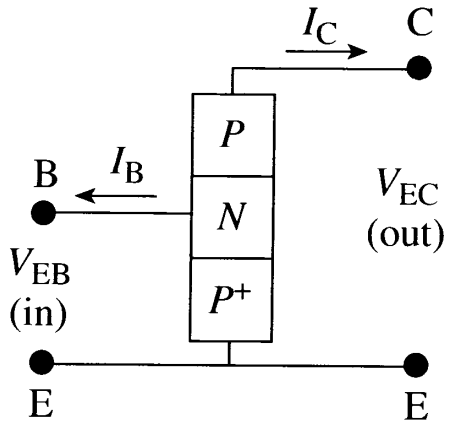
$$I_E = I_B + I_C \quad \text{.....(KCL)}$$

$$V_{EC} = V_{EB} + V_{BC} \quad \text{..... (KVL)}$$

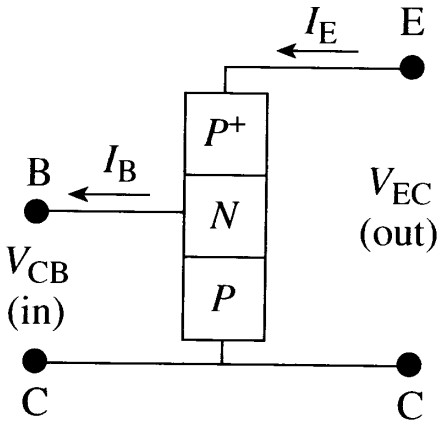
BJT configurations



(a) Common base



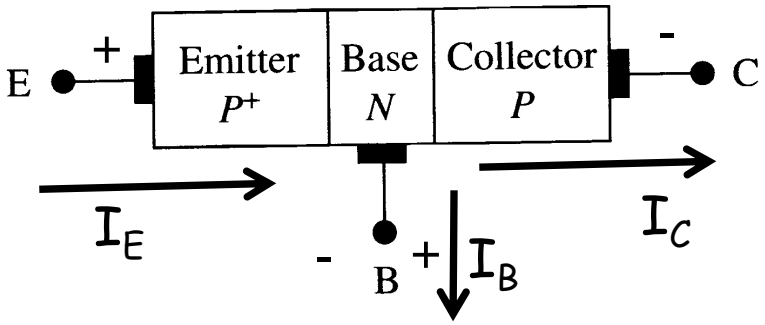
(b) Common emitter



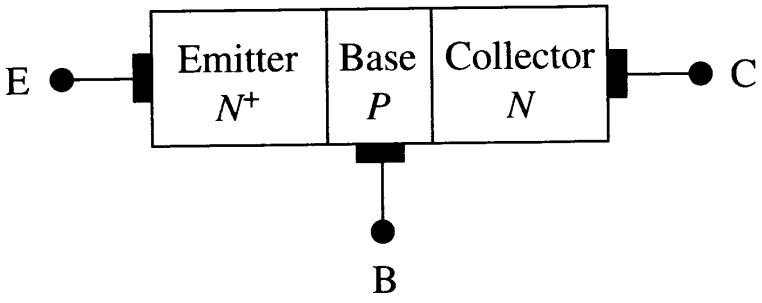
(c) Common collector

GAIN CONFIG

Bipolar Junction Transistors: Basics



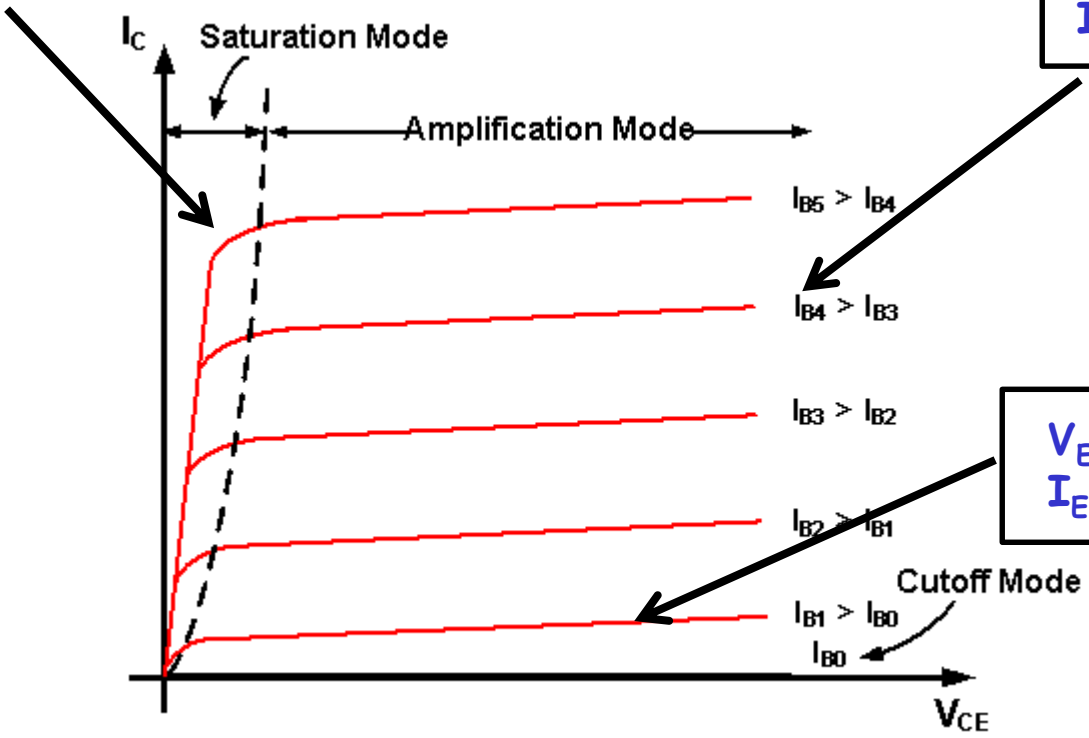
(a) *pnp*



(b) *npn*

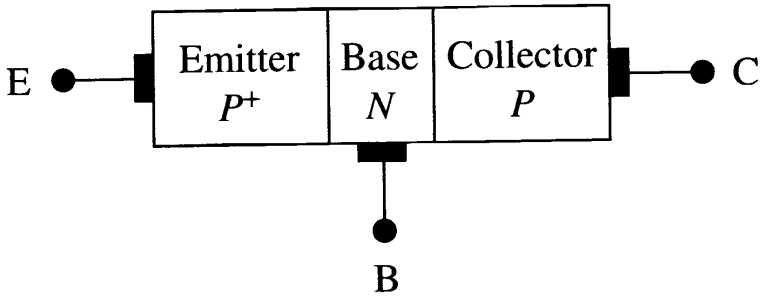
$V_{EB} > -V_{BC} > 0 \rightarrow V_{EC} > 0$ but small
$I_E > -I_C > 0 \rightarrow I_B > 0$

$V_{EB}, V_{BC} > 0 \rightarrow V_{EC} >> 0$
$I_E, I_C > 0 \rightarrow I_B > 0$

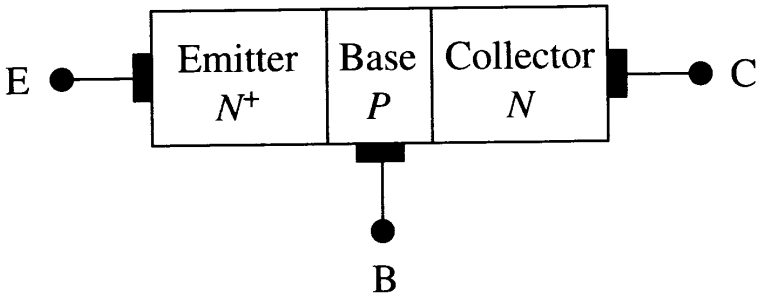


$V_{EB} < 0, V_{BC} > 0 \rightarrow V_{EC} > 0$
$I_E < 0, I_C > 0 \rightarrow I_B > 0$ but small

Bipolar Junction Transistors: Basics



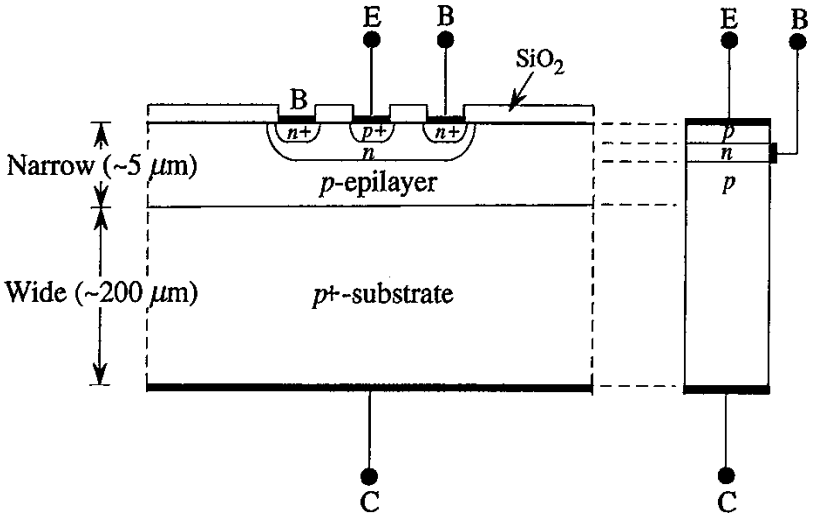
(a) *pnp*

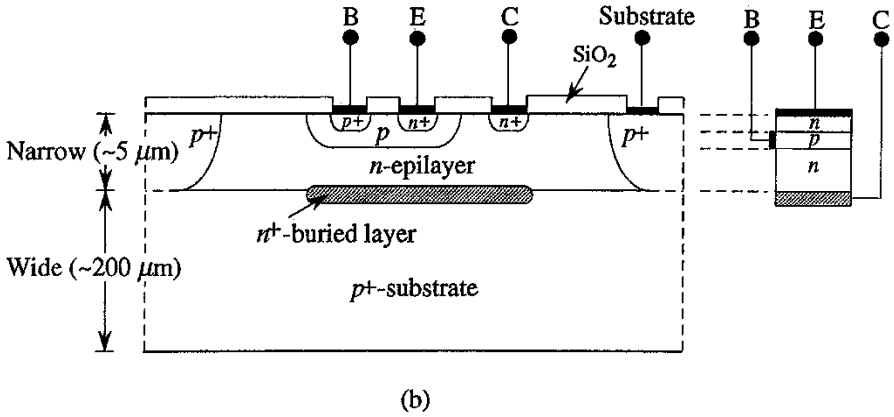


(b) *npn*

Bias Mode	*E-B Junction*	*C-B Junction*
Saturation	Forward	Forward
Active	**Forward**	**Reverse**
Inverted	Reverse	Forward
Cutoff	Reverse	Reverse

BJT Fabrication





(b)