Transistors (1)

• Bipolar Junction Transistor
  – Abbreviation: BJT
  – Two p-n junctions
  – Two different types
    • NPN transistor
    • PNP transistor
Transistors (2)

- Bipolar junction transistor (continued)
  - Applying Voltages
    - Does not help
    - Whatever polarity
    - One junction blocks anyway
Transistors (3)

- Bipolar junction transistor (continued)
  - Third lead
    - Insulating region vanishes
    - Controls the flow of electric current
    - Acts like a switch

WOW!
Transistors (4)

• Bipolar junction transistor (finished)
  – Two types
    • NPN transistor
    • PNP transistor
  – Three leads
    • Base
    • Collector
    • Emitter

NPN transistor

PNP transistor
Transistors (5)

• NPN Transistor
  – Current from collector to emitter flows ...
  – ... if current flows into the base
  – A positive voltage between base and emitter is necessary
Transistors (6)

- **NPN Transistor** (continued)
  - Transistor as switch
    - Load at collector
    - Controlled by base
      - On if $V_{BE} > 0$
      - Off if $V_{BE} = 0$
    - Active high
      - On if base is high
      - Off if base is low
Transistors (7)

• **NPN Transistor** *(finished)*
  – Example: BC547
    • Maximum collector current
      – $I_C = 100$ mA
    • Base saturation voltage
      – $V_{BE} = 0.7$ V
    • DC current gain
      – $h_{FE} = \frac{I_C}{I_B}$
      – $h_{FE} \approx 250$
Transistors (8)

• PNP Transistor
  – Current from emitter to collector flows ...
  – ... if current flows out of the base
  – A negative voltage between base and emitter is necessary
• **PNP Transistor** (continued)
  – Transistor as switch
    • Load at collector
    • Controlled by base
      – On if $V_{BE} < V_{CC}$
      – Off if $V_{BE} = V_{CC}$
    • Active low
      – On if base is low
      – Off if base is high
Transistors (10)

• PNP Transistor (finished)
  – Example: BC557
    • Maximum collector current
      – $I_C = -100$ mA
    • Base saturation voltage
      – $V_{BE} = -0.7$ V
    • DC current gain
      – $h_{FE} = \frac{I_C}{I_B}$
      – $h_{FE} \approx 250$
Transistors (11)

• MOSFET
  – Metal-Oxide-Semiconductor
  – Field-Effect Transistor
  – Controlled by voltage
    • No current necessary
  – Used in Chips
    • Integrated Circuits
Transistors (12)

- **BJT versus MOSFET**
  - NPN / N-Channel
  - PNP / P-Channel

![BJT Diagram](image)

![MOSFET Diagram](image)